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REVISION 6

NAVAL SHIPS' TECHNICAL MANUAL
CHAPTER 074

VOLUME 3 - GAS FREE ENGINEERING

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NOTE

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CHAPTER 074

VOLUME 3
GAS FREE ENGINEERING

SECTION 18
GAS FREE ENGINEERING PROGRAM REQUIREMENTS

074-18.1 INTRODUCTION

Entry into, or work in or on confined spaces may cause fires, explosions, injury, illness or death. Hazards result from flammable or explosive materials or atmospheres, toxic materials or atmospheres, or oxygen-depleted or -enriched atmospheres. If not normally inhabited, such confined spaces shall be considered unsafe for entry or work until they have been tested and issued the required Navy Gas Free Certification and Test Log (see **NSTM Chapter 074, Volume 3**, **Section 20**). Definitions necessary for using **NSTM Chapter 074, Volume 3**, are in the Glossary.

074-18.2 BACKGROUND

The U.S. Navy has long practiced the science of gas free engineering (GFE) to protect life and U.S. government property. In 1970, the Occupational Safety and Health Act, PL 91-596, was signed into law to establish regulations and standards which govern occupational safety and health matters including gas free engineering. These regulations and standards are specified in the Code of Federal Regulations (CFR), Title 29 for many aspects of gas free engineering. The National Institute for Occupational Safety and Health (NIOSH) conducts research and prepares recommendations for safety and health standards in support of OSHA. Department of Defense Occupational Safety and Health Program Instruction, DOD 6055.1 and Navy Occupational Safety and Health (NAVOSH) Program Manual Instruction, OPNAVINST 5100.19 (series), provide overall guidance to conduct gas free engineering programs. Additional sources of written information are listed in Appendix A, Gas Free Engineering Information Sources (Shipboard).

074-18.3 APPLICABILITY

The information and procedures in this volume apply to all Naval surface ships and submarines. For shore operations (including ship overhaul and repair at Naval Shore Facilities) NAVSEA S6470-AA-SAF-010, **U.S. Navy Gas Free Engineering Program** is the applicable volume. When in a private shipyard, 29CFR1915 is the applicable reference. COMFLTFORCOMINST 4790.3, Joint Fleet Maintenance Manual (JFMM), Volume IV, Chapter 25, should be the first point of reference when in port, as it will guide Gas Free Engineering personnel to the correct governing documents. Although **NSTM Chapter 074, Volume 3** does not apply directly to diving operations (which are conducted in accordance with NAVSEA 0994-LP-0021-9010 and -9020, **Navy Diving Manual**), the intent of this gas free engineering program shall be implemented insofar as practicable.

074-18.4 SCOPE

This manual provides policy, information, guidance and the minimum requirements for gas free engineering aboard Naval ships afloat. However, it cannot cover all conceivable operations and conditions. All personnel involved, therefore, shall understand the underlying intent and principles so that in unusual circumstances, appropriate procedures to protect personnel and the ship can be followed.

074-18.5 BASIC PROGRAM REQUIREMENTS

A gas free engineering program shall, at a minimum, include:

a. Observance and enforcement of the procedures specified herein for all applicable confined space entry or work.

b. Staffing of the gas free engineering program with sufficient trained, qualified and certified personnel.

c. Procedures for contacting and utilizing gas free services personnel.

d. Inspection of operations for compliance with this volume.

e. Equipping the gas free engineering program with sufficient operable calibrated test instruments.

f. Training of ship's force to recognize hazards and safety precautions for confined spaces. Training shall include procedures for requesting gas free services and procedures for helping shipmates in an emergency.

g. Documentation by required records and logs.

074-18.6 STAFFING

All Navy surface ships shall be adequately staffed with personnel trained, qualified and certified in accordance with paragraph 074-18.9 to perform gas free engineering services. At a minimum, each ship shall have:

a. One person properly trained, qualified, and certified as a shipboard (afloat) gas free engineer (GFE).

b. When specified by the commanding officer (CO), one person trained, qualified, and certified as a gas free engineer assistant (GFEA) to perform duties as specified by the GFE; and

c. A sufficient number of gas free engineering petty officers (GFEPOs), trained, qualified, and certified to meet the workload requirements of the particular ship, to include at a minimum, one GFEPO per ship's inport emergency team (IET), one per Damage Control Repair Station (DCRS), and one on the At Sea Fire Party.

In addition to the GFE staff, the fire marshal(s) (FM[s]) is assigned specific hot work duties. These responsibilities are set forth in NTTP 3-20.31.

On submarines, the medical department representative (MDR) serves as the GFE and shall be trained and qualified in accordance with paragraph 074-18.9 to perform gas free engineering services. The MDR's GFE services are strictly limited to underway periods. In port GFE services must be obtained from the supporting Naval Maritime Facility (NMF) Regional Maintenance Center (RMC). If in port without a supporting NMF, the MDR may check spaces gas free only for submarine personnel. The MDR shall not, under any circumstances, provide gas free services to DOD or contractor civilian personnel in port. NMF GFE personnel may provide GFE services for DOD personnel as outlined in paragraph 074-18.12.1.

074-18.7 BASIC AND LEGAL PROVISIONS FOR GAS FREE ENGINEERING TRAINING

The training and qualification requirements for gas free engineering personnel are the result of careful evaluation of the following factors:

a. Normal extent of confined space entry and work aboard surface ships

b. Knowledge, experience and capabilities required to recognize, evaluate and control gas free engineering hazards.

c. Requirements of Public Law 91-596, Occupational Safety and Health Act (OSHAct) of 1970.

d. Full understanding of the operation, precautions and limitations of equipment to be worn or used in the space, including:
   1. Personnel protective equipment (PPE)
   2. Safety equipment
   3. Confined spaces understanding

Shore activity gas free engineering personnel qualification requirements are contained in NAVSEA S6470-AA-SAF-010, U.S. Navy Gas Free Engineering Program. Gas free engineering personnel shall be utilized only for the category for which they have been certified except as authorized herein. An introduction to gas free engineering is included as Appendix B. This appendix may be made into view graphs for use with training courses.

074-18.8 GAS FREE ENGINEERING PERSONNEL (GFEP)

GFEP are defined as the GFE, the GFEA and GFEPO(s). The GFE is responsible for establishing and administering the overall shipboard GFE program consistent with the requirements of this volume and with other pertinent safety, health and fire protection standards.

The GFEA and GFEPOs shall perform the duties and responsibilities specified herein as assigned by the shipboard GFE. Detailed duties and responsibilities of the GFE, GFEA, and GFEPO are set forth in paragraph 074-18.17. The FM has specific hot work duties, set forth in Sections 19 and 22 of this volume. The full responsibilities of the FM are set forth in NTTP 3-20.31.

The categories of shipboard GFEP, with required qualifications for certification, are as follows:

a. GFE, shipboard (surface afloat). The GFE shall be a chief petty officer or above and shall have satisfactorily completed the formal gas free engineering (afloat) training course specified in paragraph 074-18.9. The GFE shall also complete 40 hours of practical on-the-job training (OJT) under the supervision of an official GFE aboard ship or at a maritime shore activity. The GFE shall be certified by the CO, by means of a written letter of designation placed in the member's service record following the successful completion of training and practical requirements.

NOTE

The CO may waive the 40-hour OJT requirement provided the candidate has graduated from an approved GFE training site within the last 36 months and the unit does not have a qualified GFE on board. This waiver must be in writing in the Letter of Designation.

b. GFEA, shipboard (surface afloat). The GFEA shall be an E-6 or above, shall have satisfactorily completed the formal GFE (afloat) training course specified in paragraph 074-18.9.a or 074-18.9.c, and have written authorization from the ship's CO to perform gas free engineering functions in the form of a written letter of designation placed in the member's service record.

c. GFEPO (surface afloat). The GFEPO shall be an E-4 or above and shall have satisfactorily completed the formal training course specified in paragraph 074-18.9.a. Upon finishing the course, the GFEPO shall complete the applicable gas free engineering sections of the current Personnel Qualifications Statement (PQS) for, Gas Free Engineering Petty Officer, NAVEDTRA 43704, Watchstation 316, Gas Free Petty Officer, under the supervision of the shipboard GFE. GFEPO(s) shall have written authorization from the ship's CO to perform

gas free engineering functions also in the form of a written letter of designation placed in the member's service record. This provides the ship's crew the ability to go to a greater number of duty sections with qualified personnel.

d. FM(s). The FM(s) shall have completed the applicable portions of current emergency party PQS, Gas Free Engineering Petty Officer, NAVEDTRA 43704 and have written authorization from the ship's CO to perform duties also in the form of a written letter of designation placed in the member's service record.

e. GFE (subsurface afloat). The GFE (subsurface afloat) shall meet the requirements for acceptance into and satisfactorily complete, the Naval Undersea Medical Institute (NUMI) Nuclear Submarine Medicine Course specified in paragraph 074-18.9.b.

All GFEP shall be trained in emergency rescue procedures and gas free engineering procedures and techniques, as outlined in Section 25 and in Basic Life Support (BLS); cardiopulmonary resuscitation (CPR) per the requirements of the American Heart Association or Military Training Network.

074-18.9 GAS FREE ENGINEERING TRAINING

All ship's personnel shall receive GFE familiarization during shipboard indoctrination and annually thereafter. Division officers shall arrange with the gas free engineer for personnel and training aids to conduct this training. Appendix B of **NSTM Chapter 074, Volume 3** may be used. Records of such training shall be maintained by the GFE. Three official training courses have been established for gas free engineering personnel.

a. Course title - ″Gas Free Engineer and Gas Free Engineering Petty Officer for Surface (Afloat) Operations″, Course K-495-0051.

b. Course title - ″Submarine Force Independent Duty Corpsman″, NUMI course at Naval Submarine Base, New London, Groton, CT.

c. Course title - ″Damage Control Assistant/ Senior Enlisted (DCASE)″ Course, A-4G-1111, Surface Warfare Officers School Command, Learning Sites San Deigo, CA, and Norfolk, VA ″, (An integral part of this training course is instruction for certification as a GFE).

Refer to the CANTRAC for specific course availability dates and locations of schools.

074-18.10 PROGRAM EVALUATION AND RECERTIFICATION

The CO shall require the safety officer to evaluate the gas free engineering program at least annually. The evaluation shall include recertification of GFE personnel. The checklist in the NAVSEA Damage Control Website, (www.dcfpnavymil.org) , in the Library under Gas Free Engineering may be used. Both the safety officer and the GFE shall maintain copies of the annual evaluation. The safety officer shall not be the GFE. Prior to recertification, GFE personnel shall meet the following requirements:

a. GFEP to be recertified shall demonstrate that they have satisfactorily engaged in gas free engineering during the year (issue at least 10 certificates).

b. Before recertification, personnel who have not actively engaged in gas free engineering (as defined above) shall complete a minimum of five gas-free evolutions OJT to refresh their gas free engineering skills under the direct supervision of a certified GFE.

c. If the foregoing recertification methods are not feasible, GFEP may be recertified based on a practical exercise in conjunction with an oral or written examination, both of which sufficiently demonstrate capability.

d. Prior to recertification all GFEP shall complete refresher training in emergency rescue procedures.

e. Periodicity of BLS CPR refresher training shall be in accordance with the requirements of the American Heart or Military Training Networks. The safety officer shall ensure that this program is evaluated for compliance and effectiveness annually.

074-18.11 CERTIFICATION/RECERTIFICATION RECORDS

074-18.11.1 Certification/recertification letters for assigned GFEP shall be recorded in the individual's military service record and copies maintained in the GFE's notebook defined in Appendix C.

074-18.12 SHIPBOARD AFLOAT GAS FREE ENGINEER (GFE) AUTHORITY LIMITS

Shipboard GFE operations are to be limited to U.S. Naval vessels. The following authority limits and restrictions shall apply when assigning ship force Navy personnel to afloat gas free engineering (GFE) operations.

074-18.12.1 SHIPBOARD AFLOAT GFE.

a. When underway the ship force Afloat GFEs:
   1). Are authorized to conduct gas free engineering services, including cold and hot work for all military personnel aboard ship.
   2). Are authorized to conduct only cold work gas free engineering services for DOD civilian personnel aboard ship.
      (a). The only exceptions to this are certain situations concerning civilian contractors outside U.S. territorial waters, addressed in paragraph 074-18.14.

b. When in port (not underway) the ship force Afloat GFEs:
   1). Are authorized to conduct gas free services for assigned Ships Force personnel, but shall utilize a NMF GFE or NFPA Marine Chemist to certify hot work operations within, on or immediately adjacent (through heat transfer spark, or hot slag contact) to the following spaces:
      (a). Spaces that contain or last contained combustible or flammable liquidsor gases.
      (b). Tanks that contain or last contained combustible or flammable liquids or gases.
      (c). Pipelines, heating coils, pump fittings, or other accessories connected to spaces that contain or last contained combustible or flammable liquids or gases.
   2). Are authorized to conduct gas free services for entry by uniformed naval personnel not assigned to the ship in order for them to conduct assessments, inspections, and to help develop repair work packages as long as the personnel are briefed, understand, and follow the content, rules and guidance of the Afloat GFE certificate for the space before and during entry.
   3). Are NOT authorized to conduct any gas free services for DOD civilian or contractor personnel. DOD civilian and contractor personnel are required to follow the guidance of their NMF GFE or NFPA Marine Chemist.

4). Are authorized to act as a Navy Competent Person with the written approval of the NMF GFE at the NMF (e.g., Naval Shipyard, Regional Maintenance Center, or Intermediate Maintenance Activity).

c. To ensure awareness and coordination between activities working on the ship, ship's force Afloat GFEs are required to consult with the appropriate NMF GFE and/or NFPA Marine Chemist before conducting any gas free services. The ship Afloat GFE shall follow any guidance provided by the NMF GFE and/or NFPA Marine Chemist. Ship's Force will not conduct gas free certifications for hot work where DOD civilians or contractors are working in the same confined and/or poorly ventilated enclosed space.

074-18.12.2 MARITIME SHORE COMMAND GFE. A maritime shore command's GFE or competent person is authorized to conduct gas free services (within their authority) for shipboard afloat operations or environments if needed.

074-18.12.3 NON-MARITIME SHORE COMMAND GFE. A non-maritime shore command's personnel are NOT authorized to conduct gas free services for shipboard afloat operations or environments, except where they have been specifically trained IAW NAVSEA S6470-AA-SAF-010 for such operations.

074-18.13 CONTRACTOR OPERATIONS INSIDE U.S. TERRITORIAL WATERS

Contractor operations which involve confined space entry or work are governed by 29 CFR 1915 for maritime operations. When contractor personnel perform work aboard Navy ships, the following provisions shall be observed:

a. When performing maritime operations, the contractor shall provide a National Fire Protection Agency (NFPA) -certified marine chemist, certified industrial hygienist or other qualified or competent person, as appropriate, under the provisions of 29 CFR 1915. If a marine chemist is not reasonably available, the contractor may provide a qualified alternate person as recommended by the Officer in Charge, Marine Inspection, U.S. Coast Guard, under the provisions of 29 CFR 1915.

b. When in U.S. territorial waters, there are no legal provisions for Navy GFEP to perform GFE services for contractor operations. Therefore, Navy GFEP shall not certify spaces for contractor operations or personnel, except where failure to do so would create an extreme emergency for personnel and property and increase potential liability. All such cases must be authorized by the CO and the service to be performed personally conducted or supervised by the GFE.

c. To protect Navy personnel, ships and facilities, the CO shall, in all cases of contractor operations aboard Navy ships, ensure that the contracting officer invokes or has invoked requirements for contractor gas free personnel and operations which shall meet the requirements of 29 CFR 1915.

d. Supervisor of Shipbuilding, Conversion and Repair and ship's force personnel may occupy spaces concurrently with contractor personnel for the purpose of monitoring contract performance or inspections based solely upon appropriate contractor representative declaration that the space is gas free. In such cases, Navy gas free engineering services (to declare the space gas free per paragraph 074-18.13.e, below) are not required but may be provided at the discretion of the CO. All other concurrent Navy and contractor work in the space must comply with the provision of paragraph 074-18.13.e.

e. When Navy and contractor personnel are to conduct work in a space at the same time, both the Navy GFE and the appropriate contractor representative shall declare the space gas free in accordance with applicable requirements. The contractor shall be informed of the Navy GFE's findings. However, despite such gas freeing and subsequent notification by Navy personnel, the contractor shall be informed that the contractor retains legal obligation for inspections and tests and for safety of contractor personnel.

074-18.14 CONTRACTOR OPERATIONS OUTSIDE U.S. TERRITORIAL WATERS

When outside U.S. territorial waters, Navy GFE personnel may perform services and certify compartments on U.S. Navy ships commensurate with their qualifications (i.e., GFE/GFEA/GFEPO) for the following categories of contractor personnel:

a. U.S. contractor personnel when at sea or in port outside U.S. territorial waters, provided that the contractor's competent person is not reasonably available.

b. Non-U.S. contractor personnel when at sea or in port outside U.S. territorial waters, provided that the host nation's competent person or alternate qualified person is not reasonably available and provided that doing so does not violate the host nation's laws, regulations, treaty agreements or contract provisions.

074-18.15 NAVY GAS FREE CERTIFICATION AND TEST LOG

The Navy Gas Free Certification and Test Log, as required by Section 20, **NSTM Chapter 074, Volume 3**, and illustrated in Appendix D, shall be issued and maintained for each confined space that is inspected or tested.

074-18.16 RECORDS RETENTION

All Navy Gas Free Certification and Test Log forms shall be maintained by the ship for a period of twelve months from completion date of the specific job for which they were generated. In addition, a Gas Free Engineering Notebook shall be maintained in accordance with Appendix C.

074-18.17 DUTIES AND RESPONSIBILITIES OF GFE PERSONNEL

GFE personnel shall perform those functions set forth below.

074-18.17.1 GFE DUTIES. The GFE shall be responsible for establishing and administering the gas free engineering program (paragraph 074-18.5) to include the following:

a. Ensure that required instruments, in sufficient quantity to meet the requirements of ship gas free operations, are procured, maintained and calibrated.

b. Ensure that all shipboard GFE personnel are properly trained, PQS qualified and certified by the CO in the following:
   1 Proper gas free engineering procedures
   2 Proper use and field calibration of instruments
   3 Selection, issue and maintenance of personnel protective equipment (PPE)
   4 Selection, issue and maintenance of respiratory protection equipment from the respiratory protection officer (RPO)
   5 Applicable emergency procedures for the specific ship.

c. Ensure that personnel and training aids are available to the division officers to conduct shipboard gas free engineering training and understand confined spaces.

d. Provide for:
   1 Evaluation and testing of confined spaces
   2 Preparation, issuance and posting of gas free engineering certificates which indicate the conditions in confined spaces

3 Control measures required for the specific space and operation

e. Establish requirements for cleaning, ventilating, inerting, pressing-up or other treatments which may be required for confined spaces.

f. Ensure that proper procedures are followed before, during and after hot work in, on or adjoining confined spaces.

g. Observe, as needed, operations to verify that personnel do not work alone (paragraph 074-19.5).

h. Review emergency rescue procedures and ensure that appropriate personnel know how to perform such procedures.

i. Ensure that work is stopped and all personnel are removed from a space if an unsafe condition is detected or suspected.

j. Notify the CO (or the appropriate department head or division officer) when any hazardous situation has been confirmed, including any cases of work stoppage or personnel evacuation.

k. Maintain gas free documentation as required, including the Navy Gas Free Certification and Test Log, Form OPNAV 5100/16(5-91) (Appendix D).

l. Develop and maintain a gas free engineering notebook. See Appendix C for guidance.

m. Conduct tests of confined spaces as required herein.

n. Conduct tests for shipboard compartments that are involved with hazardous environments caused as a result of a casualty.

074-18.17.2 GFEA DUTIES (NOT APPLICABLE TO SUBMARINES). When assigned, the GFEA shall perform the same duties as the GFE, and as detailed in paragraph 074-18.17.1.

074-18.17.3 GFEPO DUTIES (NOT APPLICABLE TO SUBMARINES). GFEPOs shall:

a. Conduct tests of confined spaces as required by this manual and as prescribed and directed by the GFE.

b. Ensure that gas free engineering certificates are correctly issued, posted, maintained and updated and that all requirements are properly observed.

c. Stop all work and require all personnel to evacuate a confined space when an unsafe condition is detected or suspected; immediately notify the GFE and the officer or petty officer in charge of the operation.

d. Maintain, field calibrate and properly utilize required test instruments.

e. Provide emergency support as required.

f. Provide personnel briefings before entry or work as directed by the GFE/GFEA.

g. Ensure that personnel do not enter or work alone or unobserved in hazardous operations or environments in confined spaces.

h. Make log entries and perform other record-keeping duties as prescribed by the GFE.

074-18.17.4 POST-FIRE ATMOSPHERIC TESTS. Shipboard personnel authorized to conduct post-fire atmospheric tests for the purpose of certifying the space safe for personnel are the GFE, the GFEAs or the GFEPOs. Post-fire atmospheric testing is covered in Section 26.

074-18.18 RESPONSIBILITIES FOR GAS FREE ENGINEERING

The following is a description of supervisory responsibilities for GFE personnel.

074-18.18.1 NAVAL SEA SYSTEMS COMMAND (NAVSEA). NAVSEA, under the direction of the Chief of Naval Operations (CNO), exercises general supervision over, and provides technical support for, the Navy GFE program for Naval ships afloat.

074-18.18.2 CHIEF OF NAVAL EDUCATION AND TRAINING (CNET). CNET establishes the curriculum for afloat GFE courses. Curricula shall meet the requirements of **NSTM Chapter 074, Volume 3**, 29 CFR 1915, COMFLTFORCOMINST 4790.3 (JFMM), and OPNAVINST 5100.19(series).

074-18.18.3 BUREAU OF MEDICINE AND SURGERY (BUMED). Provides assistance and concurrent authority in the administration of policy, procedures and curricula developed within the scope of submarine gas free engineering.

074-18.18.4 COMMANDING OFFICER (CO). The CO, consistent with U.S. Navy regulations and directives from higher authority, is solely responsible for the safety and health of personnel and the protection of property within his command. The CO must establish and be responsible for a comprehensive gas free engineering program which meets the intent and specific requirements of this volume. It is also the CO's responsibility to require that other participating agencies (including contractors) conduct their operations in accordance with applicable laws and standards. The absence of a requirement in this volume or the cited reference does not necessarily indicate that no safeguards are required. If no existing standard or regulation applies or if interpretation is necessary, the CO shall submit to Commander, NAVSEA 03, full details while taking necessary action to control the identified or suspected hazard.

074-18.18.5 DEPARTMENT HEADS, DIVISION OFFICERS AND PETTY OFFICERS. Department heads, division officers, petty officers and others who control spaces, operations or personnel covered herein shall ensure that:

a. The provisions, procedures and requirements contained in this volume are fully met.

b. GFE personnel perform prescribed inspections and tests, apply all required controls and certify spaces safe or unsafe for entry and proposed operations.

074-18.18.6 OFFICERS AND PETTY OFFICERS IN CHARGE. Officers and petty officers in charge of entry, work in or on confined spaces shall be familiar with the applicable provisions of this volume. They shall act upon potential hazards in areas and operations under their control and shall:

a. Explain to all personnel under their immediate supervision possible hazards and necessary precautions for proposed operations.

b. Strictly enforce the safety, health and fire protection requirements of this volume and pertinent referenced standards and regulations.

c. Report promptly to their immediate superiors any unsafe conditions or procedures and, if necessary, cease all operations until the situation has been corrected.

074-18.18.7 OPERATING PERSONNEL. All personnel entering or working in or on confined spaces are responsible for understanding and observing the applicable safety, health and fire protection regulations. Further, all personnel shall:

a. Report any unsafe condition, procedure or equipment to their immediate supervisors.

b. Warn personnel who are endangered by improper operating procedures.

c. Report to their superior any injury or health problem occurring in the course of duty or affecting the safe performance of duties.

074-18.19 REPORTING OMISSIONS OR ERRORS IN MANUALS

Report all errors, omissions, discrepancies and suggestions for improvements to NAVSEA technical manuals to the Naval Sea Data Support Activity (NSDSA), Naval Ship Weapon Systems Engineering Station (Code 5700), Port Hueneme, CA 93043, on NAVSEA Technical Manual Deficiency/Evaluation Report, Form NAVSEA 4160/1. Three copies of the form are included at the end of this volume. All comments will be thoroughly investigated and originators will be advised of the resulting action. Additional copies of Form NAVSEA 4160/1 may be requisitioned from Naval Publications and Form Center (NAVPUBFORMCEN), Philadelphia, PA 19120.

SECTION 19

GAS FREE ENGINEERING PROCEDURES

074-19.1 INTRODUCTION

Section 19 contains information and requirements for the conduct of gas free engineering procedures. Necessary definitions are included in the Glossary. For additional guidance, a sample gas free engineering notebook with example checklists is provided in Appendix C.

074-19.2 NEED FOR GAS FREEING

Personnel entering, or working in or on confined spaces may encounter hazards, including:

a. Lack of sufficient oxygen to support life

b. Excessive levels of oxygen which increase the danger of fire or explosions

c. Presence of flammable or explosive atmospheres or materials; and

d. Presence of toxic atmospheres or materials

Because hazards are not always readily apparent, nor detectable by odor or sight, it is imperative to test for hazardous conditions prior to entering confined spaces.

074-19.3 SOURCES OF CONFINED SPACE HAZARDS

Many factors need to be evaluated before entry into, or work in or on confined spaces. Such evaluations shall include, at a minimum:

a. Whether present or previous contents have introduced flammables, toxicants or oxygen-depletion or -enrichment. For example:
   1 Spaces containing organic materials such as fruits, vegetables, natural lines or standing sea water will potentially deplete the oxygen and further deteriorate into hydrogen sulfide and, potentially, methane.
   2 Rust is a good indicator of potential oxygen deficiencies and hydrogen gas buildup.
   3 Spaces which have been painted and immediately closed, or freshly painted spaces, can cause oxygen deficiency and produce other potentially toxic gases or vapors.

b. Whether the location and configuration of the space (including restricted access, obstructions or remoteness) may inhibit or interfere with movement, ventilation, escape, rescue or fire fighting.

c. Whether the types of operations to be conducted within the space can produce toxicants, flammables, oxygen-depletion or -enrichment or ignition sources.

d. Whether fixed equipment (i.e., piping systems, conduits, ducts, machinery or pressurized lines) within the space are potentially hazardous.

Caustic substances can react with aluminum to produce a chemical reaction which creates hydrogen as a by-product.

e. Whether there are other hazards, such as slippery surfaces, restricted walkways or ladders, poor illumination or hazardous materials present.

f. Whether the contents or the nature of the boundary spaces may result in fires or explosions because of the work being done in the space.

g. Whether environmental conditions may contribute to confined space hazards.

Elevated ambient temperature may cause accelerated vaporization, seepage or leakage of volatile solvents.

h. Whether additional hazards may be created by work interruptions (i.e., creation of a hazardous atmosphere from direct vaporization of solvents or from solvent-soaked rags), welding or cutting torches that have remained in the space or securing of space ventilation during the interruption. Appendix E provides a list of common shipboard material sources which can produce off gas hazards. It also lists the gas hazards and methods of detection to be used. Atmospheric hazards can be introduced into confined spaces by products (fuels, gases), processes (welding, spray painting, solvent cleaning, etc), and forms of reactivity (such as the formation of hydrogen sulfide from organic decay or the consumption of oxygen due to decomposition of material or rust).

074-19.4 ENTRY AND WORK RESTRICTIONS FOR CONFINED SPACES

All confined spaces shall be considered hazardous. Entry into, or work in or on such spaces is restricted as specified on the posted gas free certificate. The Navy Gas Free Certification and Test Log is described in Section 20 and illustrated in Appendix D. Results of gas free tests may dictate further restrictions. (See paragraph 074-19.13). The following shall apply to confined spaces:

a. Entry by non-GFE personnel or work in confined spaces is prohibited until such spaces have been inspected, tested and certified safe for entry or work, or both.

b. Entry into, or hot work in or on fuel tanks, spaces in which fuel tank vents terminate, piping or equipment servicing such spaces or other confined spaces known to contain flammable fuels or fuel vapors is permitted only if approved by the CO for each occasion. Treat tanks as IDLH and follow procedures in paragraph 074-19.14.

Eductors located in remote spaces, such as pump rooms, if activated, can remove all breathing air, making the space immediately dangerous to life or health (IDLH). Ensure sufficient make-up air is provided and the space has adequate oxygen prior to entry in all eductor-equipped remote spaces.

c. Use only approved, intrinsically safe, spark-proof or explosive proof equipment when oxygen-enriched atmospheres or flammable or explosive vapors, gases or materials are present. Control all other potential ignition sources and provide adequate fire protection measures for the specific exposure.

d. When materials and conditions within the space introduce flammables, toxicants or unsafe oxygen levels,

identify and remove the cause or source of the contamination by cleaning, flushing and draining, tagging out, isolating or plugging and ventilating before entry or work. Maintain adequate ventilation for the duration of the work.

e. When operations such as spray finishing, interior coating, welding, cutting or solvent cleaning can introduce flammables, toxicants or oxygen abnormalities within the space, observe the following restrictions:

1 When toxic or flammable atmospheres or materials or oxygen-deficient or -enriched atmospheres are present or may be introduced into the space, provide general ventilation, dilution ventilation, local exhaust ventilation or a combination thereof in accordance with Section 21. Additional requirements for spray painting and solvent cleaning may be found in **NSTM Chapter 631, Volume 2 - Preservation of Ships in Service Surface Preparation and Painting**.

2 When toxic atmospheres or materials are present or may be introduced in the space, personnel shall wear NIOSH-approved respiratory protective equipment (regardless of ventilation) and any other required personnel protective equipment (PPE). To help determine the correct PPE for the hazard involved, refer to paragraph 074-19.7, OPNAVINST 5100.19 (series), **NSTM Chapter 077, Personnel Protection Equipment, Hazardous Material User's Guide (HUG)** and the Material Safety Data Sheet (MSS). A guide for reading an MSDS is found in Appendix F.

3 When flammable materials, gases, vapors or oxygen-enriched atmospheres are present or may be introduced into the space, use only approved, intrinsically safe, spark-proof or explosive-proof equipment and control all potential ignition sources.

074-19.5 WORKING ALONE

Personnel in any confined space shall always work with an observer or an outside attendant. Maintain communication between personnel outside the space and personnel entering or working inside. The type of communication (such as voice or signal line) and the frequency of contact (continuous or periodic check) shall be determined by the GFE/GFEA based on the nature of the space, operations and degree of hazard.

074-19.6 EXPOSURE LEVELS

Exposure limits of contaminants may be expressed in many different ways. For most contaminants, a safe exposure limit is based upon an 8 hour time-weighted average (TWA) calculation such as OSHA's permissible exposure limits (PELs) and the American Conference of Governmental Industrial Hygienists' (ACGIH) threshold limit values (TLVs). The PELs, published in the "Z Tables" of 29 CFR 1910, have been law since the Occupational Safety and Health Act of 1970 and are replicated in Appendix G of this manual. Because the ACGIH is not a US Government body, their TLVs are recognized internationally.

OSHA, as an additional control for toxic atmospheres, imposes "action levels," which is one-half the PEL or TLV. Marine Chemists and Navy GFEs usually will not permit entry once the readings reach this level. Besides TWA-based levels, exposure to contaminants may be expressed as short-term exposure limits (STEL), ceilings (C), and immediately dangerous to life or health (IDLH). See Glossary for definitions.

Personnel exposure to toxic materials shall not exceed permissible exposure limits (PELs) specified in Appendix G, Permissible Exposure Limits, without the use of NIOSH-approved respiratory devices appropriate for the toxicants present or expected from planned evolutions. Exhaust ventilation is required even with respiratory protective devices. Exposure to toxic materials in excess of NIOSH IDLH levels requires extra levels of precautions and should only occur when absolutely necessary. The Commanding Officer's approval is required when entering IDLH spaces in accordance with procedures outlined in paragraph 074-19.14.

074-19.7 PERSONNEL PROTECTIVE EQUIPMENT (PPE)

Supervisors of personnel entering or working in confined spaces shall ensure the use of PPE appropriate to the operation, exposure and expected hazards. The GFE shall enforce PPE use by GFE personnel. PPE shall be available when needed, maintained in good condition, and cleaned daily after contact with irritants, caustics or toxic materials (such as fuels or sludge). For more detailed information concerning PPE and other GFEP equipment, refer to Appendix H.

074-19.8 RESPIRATORY PROTECTION

Only NIOSH-approved respirators shall be utilized for GFE operations. All exposures or potential exposures must be carefully evaluated before proper respiratory protective devices can be selected. Such evaluation shall include, at a minimum:

a. Atmosphere as a whole, i.e., whether or not space is IDLH.

b. Oxygen level

c. Types of contaminants present or likely to be present or generated (mists, fumes or vapors)

d. Concentrations of contaminants

e. Appropriate exposure limits of contaminants: threshold limit value (TLV), permissible exposure limits (PEL), threshold limit value ceiling (TLVC). See Glossary for definitions.

074-19.9 BREATHABLE AIR

Provide breathable air according to the following guidelines:

a. Compressed breathable air supplied to respiratory protective devices such as a self-contained breathing apparatus (SCBA), shall, at a minimum, meet the Compressed Gas Association (CGA) G-7.1 requirements for Grade D (compressor source air) breathable air. The requirements for Grade D breathable air are shown in Table 074-19-1.

b. Air intakes for blowers, compressors or ventilation makeup air shall be placed so that vapors, exhaust gases, particular matter and other contaminants will not be drawn into the systems or into confined spaces.

Table 074-19-1. ANSI REQUIREMENTS FOR BREATHABLE AIR

Component	Grade D (compressor air) Breathable Air
Oxygen (by volume) percent	19.5 to 23.5
Carbon dioxide (by volume)	1,000 ppm maximum
Carbon monoxide (by volume)	10 ppm maximum
Oil (weight/volume)	5 mg/m^3 maximum
Moisture (weight/volume)	20 mg/m^3 maximum

074-19.10 ACCESS TO HAZARDOUS SPACES

Provide more than one means of access to a confined space having a hazardous atmosphere, or in which ongoing work may generate a hazardous atmosphere (except where the structure or configuration of the space makes this impractical), as follows:

a. Multiple access spaces. If a ventilation duct blocks one access to a multiple access confined space, ensure that at least two other accesses are kept clear for immediate use.

b. Single access spaces. Breakaway ducting shall be used whenever ducting restricts entry into a single access confined space, with a possibly hazardous atmosphere. In addition, the structure, arrangement or configuration of the ventilation duct partially or completely blocks access, personnel working inside the space shall wear NIOSH-approved SCBAs or Escape SCBAs, safety belts and lifelines. Station an attendant outside the space to render aid in an emergency. In addition, follow the emergency procedure requirements of Section 25.

074-19.11 TESTING PROCEDURES AND RESULTING RESTRICTIONS

The testing and examination of a confined space shall consist of certain routine steps. Some multi-gas detectors can conduct all or some of these steps simultaneously. The steps are as follows:

a. Initial testing shall be performed from outside the space by drop test or by insertion of sample probes or hoses.

b. First, test for oxygen content using an approved oxygen meter. The normal oxygen level of ambient air at sea level is 20.9 percent. Oxygen levels less than 19.5 percent will be considered unsafe and require the use of an Escape SCBA, for further testing inside the space. Oxygen levels less than 19.5 percent or greater than 22 percent shall be considered as IDLH.

Any reading other then 20.9 percent (+/- 0.3 percent) should be investigated. Since the oxygen indicator measures in percent by volume, a 1% drop in reading from 20.9% to 19.9% (while being legally safe for workers) could indicate the presence of 1% (10,000 ppm) of a toxic contaminant.

c. Second, test for combustible vapors or gases with an approved combustible gas indicator. Concentrations of ten percent or greater of the LEL shall render the atmosphere IDLH.

Although concentrations below ten percent of the lower explosive limit (LEL) may not present a flammability hazards, it may still present a toxic hazard. Consider a substance (Benzene) with an LEL of 1.2% by volume (equivalent to 12,000 ppm). A CGI reading of 10% of the LEL would equate to 1,200 ppm, and even a “safe” reading of 1% of the LEL would be equivalent to 120 ppm. With a PEL of 1 ppm and TLV of 0.5 ppm, one can easily see the toxic hazard present. Also, it shall be considered evidence of potentially unsafe conditions due to the many variables with testing instruments and the difficulty of obtaining accurate readings.

NOTE

Many combustible gas indicators function by indicating a circuit imbalance. This imbalance is created by combustion within the meter and requires proper oxygen levels in the sample. Combustible gas indicators of this type are affected by atmospheres that are oxygen-deficient or oxygen-enriched. The oxygen requirement is a further reason for testing oxygen first.

d. Third, test for toxicants according to the nature of the space and its contents, use or operations product, processes, and reactivity. Common toxicants aboard ship include hydrocarbons, hydrogen sulfide, carbon monoxide and carbon dioxide. PELs for these and other substances may be found in Appendix G of this manual.

e. When more than one hazardous substance is present and their toxicologic effects are similar, the following additive effects formula applies to the mixture.

WARNING

When using the following equation, all concentrations must be PELs. Do not mix PELs and STELs together in the same equation.

Where air is analyzed for each component, the PEL of the mixture =

$C_1/T_1 + C_2/T_2 + C_3/T_3 =$

C = measured concentrations of substances

T = PEL of the substance

If the sum of these fractions is one or less, the PEL of the mixture is not exceeded. If the sum exceeds one, the PEL of the mixture has been exceeded.

EXAMPLE: Air contains 400 ppm of carbon dioxide (PEL = 5,000 ppm), 5 ppm carbon monoxide (PEL = 50 ppm) and 9 ppm hydrogen sulfide (PEL = 10 ppm).

$400/5{,}000 + 5/50 + 9/10 = 0.08 + 0.1 + 0.9 = 1.08$

The PEL of the mixture is exceeded.

f. When initial tests indicate deviations from normal oxygen levels or the presence of flammables or toxicants, prohibit personnel entry. Flush or drain and ventilate to remove flammables and toxicants and provide proper oxygen levels. Regardless of initial drop test results, at least two complete air changes are required prior to entry. This may circulate previously undetectable hazards (i.e. heavy gases such as hydrogen sulfide or hydrocarbons). After the required number of air changes, conduct a second drop test to test for additional hazards that may have been stirred up.

WARNING

All fuel tanks, chemical tanks, sewage system tanks (including all piping associated with these systems) or similar high hazard areas shall be treated as IDLH

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regardless of test readings until the tank/area has been emptied, cleaned and ventilated to remove contaminants and is certified as Safe for Personnel by the GFE/GFEA.

g. When follow-up/retesting shows that the atmosphere in the space is not IDLH and personnel need to enter the space (i.e., to plug piping, close valves or to clean), the following restrictions shall apply:
   1. The GFE/GFEA shall authorize each entry into spaces that contain flammable, toxic, oxygen-deficient or oxygen-enriched atmospheres.
   2. Continuous ventilation of the space shall be maintained.
   3. The GFE/GFEA shall personally specify the respiratory protection, personnel protective clothing, intrinsically safe, spark-proof or explosion-proof equipment and tools, fire extinguishing equipment and emergency rescue provisions necessary for safe entry and work.

h. When follow-up/retesting shows that the atmosphere in the space is IDLH, repair personnel may enter only as authorized by paragraph 074-19.14. Procedures for entering IDLH spaces for emergency work or rescue are provided in Section 25.

i. After the second drop test, the GFE/GFEA shall enter the space (with appropriate respiratory protection and safety measures in place) to conduct an in-space atmospheric test and a visual inspection.

074-19.12 PERIODIC AND CONTINUOUS TESTING

To maintain safe conditions during the following types of operations, the atmosphere shall be periodically or continuously tested as directed by the GFE/GFEA named on the certificate:

a. Hot work that has the potential for generating toxic fumes.

b. Hot work in the presence of hazards such as preservatives, seepage of flammables from seams or rivets or flammables trapped in blisters.

c. Application of preservatives, paints, epoxies, adhesives or other substances that may produce toxic or flammable vapors. Refer to **NSTM Chapter 631, Volume 2**.

d. Cleaning operations such as sludge removal which release toxic or flammable vapors.

e. Any similar operations or conditions (i.e., daytime elevated ambient temperatures may cause accelerated vaporization or flash point, seepage or leakage of volatile substances) that may produce or release toxic, flammable, oxygen-enriched or asphyxiating atmospheres or materials into the space or may ignite any flammable atmosphere or material present.

074-19.13 CONDITIONS FOR CLASSIFYING CONFINED SPACES AS IDLH

Observing the precautions in Section 25 is essential. A confined space classified as IDLH is one in which the atmosphere meets one or more of the following conditions:

a. Flammable vapors at a concentration of ten percent or greater of the lower explosive limit (LEL).

b. Oxygen content less than 19.5 percent by volume or greater than 22 percent by volume.

NOTE

The IDLH for submarines underway, due to the difference in the partial pressure of oxygen, is less than 16.5 percent by volume.

c. Presence of toxicants above NIOSH IDLH limits. (See Appendix G.)

074-19.14 IDLH SPACE ENTRY

Entry into IDLH spaces is authorized only under emergency conditions. Only the CO can authorize opening and entry into IDLH spaces. Specific exceptions and clarifications for entry into a known IDLH atmosphere space are provided in paragraph 074-19.14.h. The following precautions must be observed for entry into IDLH spaces.

a. The atmospheric testing plan must be approved by the GFE or in his absence the GFEA. The purpose of this planning is to:

1. Determine which type of respirators will be worn by personnel entering the space. When supplied air respirators (SARs)/SCBAs are used, the number of reserve or spare bottles to support the testing shall be determined. Refer to **NSTM Chapter 077** for guidance on the number of spare bottles required. Currently there are only two approved systems/devices approved for IDLH entry. The SAR/SCBA System can always be used for IDLH entry. Firefighting SCBAs can be used for entry and/or rescue if all the following conditions are true:

⚠ WARNING

When in doubt use the SAR/SCBA System for entry, failure to use the correct respiratory can lead to injury or death.

(a). Compartment to be inspected is only one space removed from non-IDLH atmosphere and the obstacles in the space can be navigated without removing firefighter's SCBA.

(b). Time required to reach the furthest point and conduct testing is less than 20% of a fully charged 45-minute SCBA firefighter's SCBA capacity, approximately 3,600 psig remaining or 9 minutes. (30-minute firefighter's SCBAs are prohibited.)

(c). Vertical entry is limited to two decks in height and complies with limitation (a).

(d). Purpose for entry is to inspect, certify, take measurements, or as a first responder in a rescue. Rescues require immediate notification CO and the movement of appropriate equipment to scene.

2. When supplied air respirators SAR/SCBA System is used, the number of reserve or spare bottles to support the mission shall be determined. Refer to NSTM Chapter 077 for guidance on the SAR/SCBA System and the number of spare bottles required.

2. Define the survey route and locations in the space where atmospheric sampling will be conducted.

3. Identify obstacles in the space which could impede testing or which are safety hazards, such as the deck contour, deck beams, moisture or fluids on the deck, height to the overhead and pipe runs in the space. Ship's plans and damage control plates can be used to determine the structural characteristics of the space.

4. Determine the test equipment required for atmospheric testing and the safety equipment required to support personnel in the space. This equipment, which must be intrinsically safe, may include a combustible

gas indicator, oxygen monitor and portable explosion-proof lighting. Additionally, the order in which this equipment is brought into the space should be determined.

When conducting atmospheric testing in an IDLH space, the person deployed inside the IDLH space shall maintain two-way communication at all times with a person deployed outside the space at the entrance. Communications may be by voice, phone, radio or by messenger.

5. Establish the means for communicating between personnel in the space and attendants. For larger spaces or ones which have obstacles which can impede testing or are safety hazards, phones, radios or a messenger should be used to pass information and testing progress between test personnel in the space and attendant personnel outside the space.
6. Determine the number of personnel needed in the space to conduct testing.
7. Determine the amount of time personnel must be inside the space to conduct testing.
8. Maintain continuous testing of the atmosphere in the space, as set forth in paragraph 074-19.13.
9. Establish a plan to rescue personnel from the space should they become incapacitated during the testing. Refer to Section 25 for guidance in developing a rescue plan.
10. The medical department representative (MDR) shall be informed and requested to be ready to respond immediately in case of an emergency. In addition, the following personnel shall be informed before the work starts and after it completes:
    (a). When underway: The damage control assistant (DCA), the engineering officer of the watch (EOOW), cognizant department head and officer of the deck (OOD).
    (b). When inport: The command duty officer (CDO), duty engineer, cognizant department head, OOD, FM and damage control central (DC central).

b. The GFE/GFEA shall conduct a briefing of the personnel who support the gas free evolution. The briefing will detail the testing plan, rescue plan, ventilation plan, obstacles impeding testing or rescue, safety precautions and personnel assignments.

c. Personnel required to conduct or support atmospheric testing and a description of each person's responsibilities are listed below:
    1. GFE - GFE (or GFEA, in the absence of the GFE) directs the entry operation at the access to the IDLH space.
    2. GFEP - performs the atmospheric testing in the space.
    3. Master at Arms - assists the GFE in management of personnel in the vicinity of the IDLH space.
    4. Messenger - enters the space with the GFEP when necessary, assists the GFEP by carrying test and support equipment and passes information between the GFEP and attendants, when required.
    5. Attendants - personnel stationed outside the space at the access who support test personnel. Attendants' responsibilities include:
        (a). Maintaining communications with personnel conducting atmospheric testing within the space.
        (b). Maintaining communications with DC central.
        (c). Monitoring the breathing air supply to personnel conducting atmospheric testing if the SAR/SCBA System is used. One attendant shall be assigned for each breathing air supply manifold enclosure.

(d). Tending the air hose (if a SAR/SCBA System is used), the safety line and the communication lines (if used) for personnel in the space.

NOTE

Space permitting, each person inside the IDLH space shall have one attendant at the space access to tend that person's air hose and lines. At a minimum, two attendants shall be located at the space access.

NOTE

The safety line shall be 1/2-inch diameter (or larger) nylon line (length determined by size of space) and attached to the harness with a snap hook.

(e). Erect and man hoisting equipment in case personnel must be retrieved vertically from the space.

6. Rescuers - Rescue personnel shall be stationed near the access to the IDLH space wearing (in standby) the respiratory protection specified for IDLH spaces. Rescue personnel shall be ready to enter the IDLH atmosphere as directed by the GFE/GFEA in the event that the atmospheric testing personnel within the space require assistance. The first rescuers comprise the initial response team, which includes the investigator and one rescue. The number of required rescuers shall be determined by the GFE/GFEA. If rescue personnel are required to enter the IDLH space at least one additional rescuer shall be stationed near the access to the IDLH space wearing (in standby) the respiratory protection specified for IDLH spaces.
7. DC central phone talker - a support person stationed in DC central who maintains communication with the attendant phone talker. Additionally, the phone talker passes status to the quarterdeck or bridge to expedite call-away of rescue personnel if directed by the GFE/GFEA. Other shipboard radio communications may be used if so equipped.
8. MDR - advises the GFE/GFEA regarding aid to the victim and continues aid once the victim is removed from the space.
9. Electrician - provides assistance as directed by the GFE/GFEA.

d. The GFEP shall assemble and check the equipment required for atmospheric testing of the space. The equipment to be used will include:

1. Respiratory equipment worn by all personnel who enter the IDLH atmosphere. SAR/SCBA is used, Primary Air Supply Packs (PASPs), Reserve Air Supply Packs (RASPs), and at least four airline Escape SCBAs with hose sections for each shall be available at the scene. One PASP shall be used for entry and one shall be utilized as a back-up unit for potential use during rescue.
2. Safety harnesses with attached safety lines and intrinsically safe communication devices.
3. Intrinsically safe inspection and support equipment, such as combustible gas indicator, oxygen monitor and portable explosion-proof lighting.

⚠ WARNING

Use of emergency escape breathing device(s) (EEBDs) in the rescue operation must be authorized by the GFE/GFEA. EEBDs shall not be used in atmospheres

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which are potentially explosive or if the victim must be transported on a stretcher (EEBDs interfere with stretcher head support).

4. Rescue equipment, such as EEBDs, hoisting equipment and stretcher. Prior to entry, erect and man hoisting equipment for retrieving personnel vertically from the space.

e. Personnel who enter IDLH spaces shall be equipped with:

1. A full face pressure demand Escape SCBA (part of the SAR/SCBA System). The backup cylinder shall have a rated air supply of 15 minutes. The SAR/SCBA System is described in **NSTM Chapter 077**.
2. In some circumstances, a full face pressure demand Firefighting SCBA. Firefighting SCBAs can be used for entry and/or rescue if all the following conditions are true:
   (a). Compartment to be inspected is only one space removed from non-IDLH atmosphere and the obstacles in the space can be navigated without removing firefighter's SCBA.
   (b). Time required to reach the furthest point and conduct testing is less than 20% of a fully charged 45-minute SCBA firefighter's SCBA capacity, approximately 3,600 psig or 9 minutes. (30-minute firefighter's SCBAs are prohibited)
   (c). Vertical entry is limited to two decks in height and complies with limitation (a).
   (d). Purpose for entry is to inspect, certify, take measurements, or as a first responder in a rescue. Rescues require immediate notification of CO and the movement of appropriate equipment to scene.

NOTE

Submarines use SCBAs or EABs when underway. In port, GFE is provided by IMA.

3. Safety harnesses with attached safety lines.
4. A means of communicating with attendant personnel at the entrance to the space. Communications can be by visual signals, phone or radio communications or by using a messenger to enter the space and communicate with personnel in the space and then pass information to attendant personnel.

⚠ WARNING

Equipment carried into the space must be tethered to entry personnel to prevent loss of or damage to the equipment.

f. Attendant personnel shall be continuously posted immediately outside the access to the space while personnel are within the space. Space permitting, there shall be one attendant for each person entering the space. At a minimum, at least two attendants shall be located at the space access. An additional attendant shall maintain a continuous breathing air supply if a SAR/SCBA System is used.

g. During the period that personnel are inside the IDLH space, the GFE/GFEA shall maintain the initial response team (an investigator and one rescuer) near the space and in constant contact with the attendant at the access. If these rescue personnel must enter the IDLH atmosphere, there must be a least one additional rescuer stationed near the access to the IDLH space. Rescue personnel shall maintain the respiratory protection equipment in standby and not enter the space until directed by the GFE/GFEA. Refer to Section 25 for rescue procedures.

h. The following spaces will always be considered to contain IDLH atmospheres until the space has been thoroughly cleaned and tested: CHT tanks and all system piping; fuel tanks (all types) and all system piping; chemical tanks (such as dry cleaning fluid tanks) and all system piping; AFFF concentrate piping. These tanks or systems may only be opened and entered under non-emergent conditions for the following specific situations. CO's authorizing signature is required on the space opening request and the gas free certificate for each occasion. All IDLH space opening and entry requirements of paragraph 074-19.14 must be observed.

1 CHT tanks may be opened for the purpose of visual inspection from the opening without tank entry. Camera equipment or other remote probes may be lowered through the opening.

2 Equipment in CHT and fuel tanks that are accessible from outside of the tank via inspection or flanged openings may be removed from the tank without having to clean and test the space. Once the opening has been closed or temporarily closed with a secure cover, the space adjacent to the tank opening may be tested for safe atmosphere and IDLH requirements relaxed by the GFE.

3 IDLH restrictions will be in effect when initially breaking into the CHT or fuel system piping for the purpose of making system repairs. IDLH restrictions may be relaxed by the GFE after the atmosphere in the space where the work is being performed has been tested as safe.

4 CHT piping in the vicinity of commodes, urinals, sinks and showers are not considered IDLH upstream of the water traps and where vented continuously through plumbing vents.

5 AFFF system piping may contain hazardous concentrations of hydrogen sulfide. IDLH requirements must be followed for initial opening of AFFF concentrate piping.

6 Fuel tanks designated by PMS or the Type Commander to be inspected or worked on during a scheduled availability may be entered by ship's force personnel during the period immediately prior to the availability in support of pre-arrival inspections, tank cleaning and fuel consolidation. Entry into fuel tanks designated by PMS shall be authorized by the CO following the provisions of the applicable PMS card. Entry into IDLH shall be in accordance with paragraph 074-19.14 using a SAR/SCBA System only.

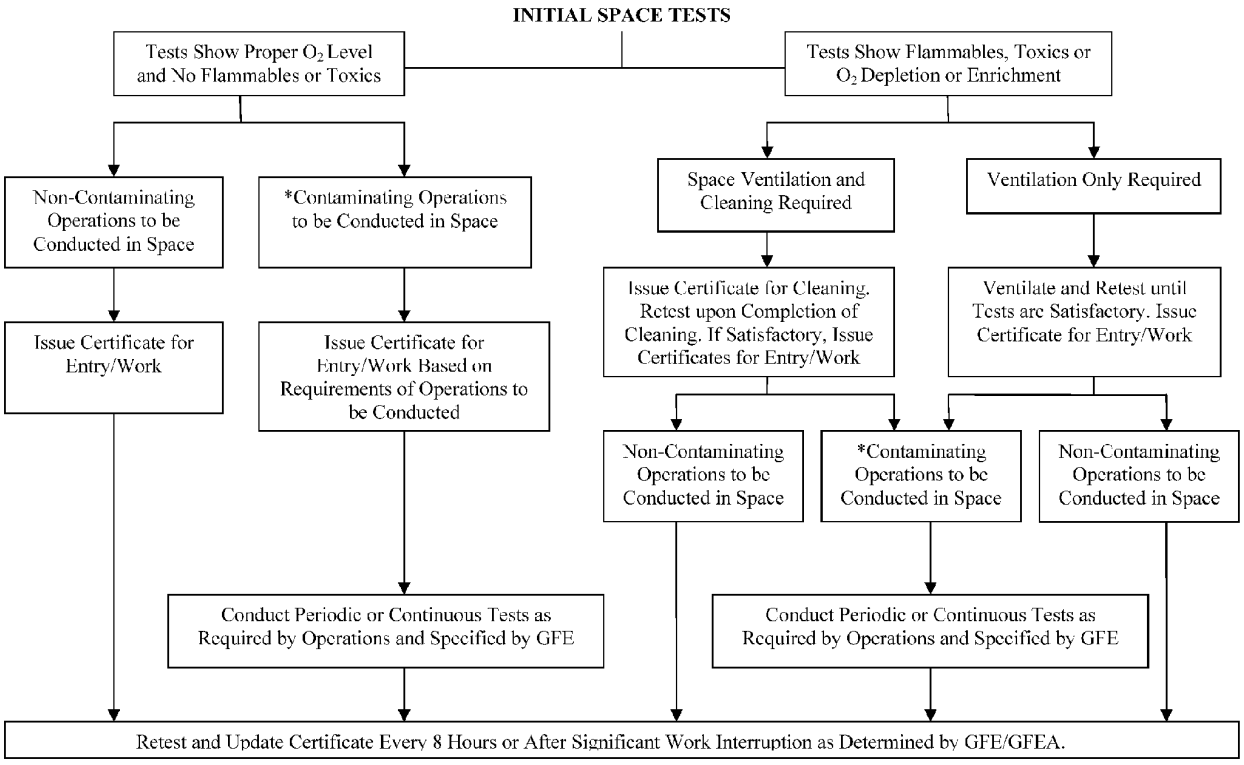
7 Personnel may enter fuel tanks for the purpose of removing damaged tank level indicators (TLI), conducting minor TLI repairs in place and for clearing fouled sounding tubes.

i. Personnel entering fuel tanks must wear Escape SCBAs, chemical resistant coveralls, gloves and foot covering for all entries. This restriction is in effect until the tank has been cleaned per the requirements of the references in paragraph 074-23.5 below. Due to a present lack of adequate instrumentation to conduct toxic gas measurement of JP-5, JP-8 and DFM vapors, the GFE can only certify the tank as gas free and safe for entry without Escape SCBA and protective clothing if there is no residual fuel present, all sludge, blisters or scales that have held fuel have been removed per paragraph 074-22.6.5 and all atmospheric tests are within safe limits.

j. Additional requirements for emergent entry or repairs to CHT tanks and piping are located in **NSTM Chapter 593, Pollution Control**. Additional information on fuel tank entry and cleaning requirements are located in **NSTM Chapter 541, Petroleum Fuel Storage, Use and Testing** and NAVSEA MIL-HDBK-291 (SH), **Military Handbook, Cargo Tank Cleaning**.

074-19.15 GENERAL REQUIREMENTS FOR ENTRY AND WORK

Figure 074-19-1, Gas Free Engineering Flow Chart, illustrates the general conditions which may be encountered on initial testing of confined spaces and those which may be caused by operations within the space which may introduce hazards into the space. Figure 074-19-1 addresses only general conditions to illustrate basic gas free testing and certification procedures in four paths and does not attempt to cover special requirements or considerations relating to items such as hot work, tag out, blanking-off, isolation and cleaning procedures. Specific requirements for initial testing and certification, retesting and updating certificates are contained in Section 20.



*Contaminating operations are those which introduce, or have the potential to introduce, hazards into the space including hot work, spray finishing, coating, solvents, inert gases or other flammables, toxics, O_2 displacement, depletion or enrichment.

Figure 074-19-1 Gas Free Engineering Flow Chart

SECTION 20
NAVY GAS FREE CERTIFICATES

074-20.1 NAVY GAS FREE CERTIFICATES

074-20.1.1 Upon completion of testing, a Navy Gas Free Engineering Certification and Test Log (Appendix D) shall be issued. This certificate shall indicate the conditions existing at the time the certificate was issued, any requirements necessary to maintain the conditions within the space and any restrictions upon operations to be conducted within the space.

074-20.2 SPACES INITIALLY CERTIFIED BY GFEPO

The GFEPO may issue certificates for initial entry and work, as follows:

a. Entry into and cold work in spaces that do not contain, or have not contained, toxic or flammable materials.

b. Hot work in or on spaces or items not described in paragraph 074-20.3.c through paragraph 074-20.3.g.

c. Operations which do not naturally generate toxic levels above the permissible exposure limit (PEL), flammables equal to or above ten percent of lower explosive limit (LEL) or result in oxygen levels below 19.5 percent or greater than 22 percent.

074-20.3 SPACES INITIALLY CERTIFIED BY GFE/GFEA

The GFE/GFEA will issue certifications for entry or work or both based on tests and inspections personally conducted by the GFE/GFEA for the following:

a. Initial certification and recertification, which includes testing of a confined space that contains or has previously contained toxic or flammable materials.

b. Initial certification and recertification, which includes testing boundary spaces that contain or have previously contained toxic or flammable materials.

c. Hot work in spaces or on the boundary of spaces which contain or have contained flammables or toxicants.

d. Hot work on connections (i.e., pipes, coils, pumps or fittings) to spaces described in paragraph 074-20-3.c. above.

e. Hot work in machinery rooms, engine rooms, catapults, bilges and similar areas where flammable or pressurized systems are likely to be present.

f. Hot work on, or adjacent to, any system or the pipe lines, coils, pumps or fittings servicing any system which contains flammables or toxicants or is pressurized in normal operation.

g. Hot work on hollow structures such as drums, jacketed vessels, booms, skegs, pipes or bitts.

h. Operations that generate or have the potential to generate toxic levels above PEL, flammables at or above ten percent of the LEL or result in oxygen levels below 19.5 percent or above 22 percent.

074-20.4 SPACES DELEGATED BY GFE/GFEA

The GFE/GFEA **may** delegate to GFEPOs responsibility for initial tests and recertification of spaces as indicated in paragraph 074-20.3, if all of the following conditions exist:

a. Written approval of the CO (in the individual's Letter of Designation).

b. Operations involved are of a repetitive, routine nature.

c. Spaces and operations involve no highly toxic or highly flammable materials such as those found in sewage systems, fuel tanks or similar spaces.

d. Testing and certifying procedures are clearly established by the GFE/GFEA in the ship's gas free instruction.

e. The GFE/GFEA has determined that the GFEPOs to whom duties are delegated are, by virtue of training and experience, properly qualified to perform the specific tasks delegated.

074-20.5 CERTIFICATE ISSUANCE

The **Navy Gas Free Certification and Test Log**, OPNAV 5100/16 (5-91) (Stock Number 0107-LF-011-7400), shall be used to record initial certification, gas free-related hot work, test results and recertification. The following are conditions under which a Navy Gas Free Certification and Test Log shall be issued:

a. Certificates for entry into, or work in or on confined spaces shall be issued immediately before entry or work. Test results shall be satisfactory before a certificate for entry or work is issued. When testing indicates hazardous conditions, stop all work and remove personnel from the space. Notify the GFE/GFEA and the appropriate supervisor immediately. Stop entry and work until all unsafe conditions have been corrected or controlled and the space has been retested and recertified.

b. The certificate duration shall not exceed a maximum period of eight hours (or less as specified by the GFE/GFEA) in the initial certification blocks (block instructions 5-8). The certificate may be extended for two additional eight-hour blocks of time for a total of 24 hours maximum per certificate by use of the recertification blocks (block instructions 49-52 and 64-67). All certificates must be closed out after a maximum of 24 hours and an entirely new certificate with a new serial number must be written to continue operations that exceed 24 hours.

c. Spaces shall be retested and recertified in accordance with paragraph 074-20.9.

d. When the space is left unmanned and unsupervised (such as breaks, lunch periods or watch changes) the space shall be retested and recertified before entry into or work on the space.

e. When contaminating operations will be conducted within the space, periodic or continuous tests which the GFE/GFEA finds appropriate shall be conducted.

f. For contaminating operations such as spray painting, welding or solvent cleaning within a confined space, the certificate shall specify applicable requirements such as ventilation, PPE, respiratory protection, intrinsically safe, spark-proof or explosive-proof equipment and suitable fire protection equipment.

g. When initial testing indicates that ventilation or cleaning, or both are required to remove contaminants from a space, a certificate shall be issued and shall specify any precautions for the cleaning process, including ventilation requirements, personnel protective clothing or respiratory protection.

074-20.6 CERTIFICATION AND TEST LOG USAGE AND CONTENTS

The Navy Gas Free Certification and Test Log (also known as the Navy gas free certificate), illustrated in Figure 074-20-1 and Appendix D, contains the following categories:

SERIAL # –1– NAVY GAS FREE CERTIFICATION AND TEST LOG

INITIAL CERTIFICATION

SHIP/UNIT/ACTIVITY: –2–

ITEM/COMPARTMENT/SPACE: –3–

TYPE OF OPERATION TO BE CONDUCTED: –4–

INITIAL DATE OF TEST: HOUR: –5– DATE: –6–

INITIAL EXPIRATION: HOUR: –7– DATE: –8–

VENTILATION REQUIRED: –9– YES NO

TYPE: –10–

INERTED GAS: –11– (gas)
OR
PRESSED UP WITH: –12– (liquid)

REQUIREMENTS/CONCLUSIONS/PRESCRIBED PRECAUTIONS/INSTRUCTIONS:
–13–

GAS FREE RELATED HOT WORK

POS QUALIFIED FIRE WATCHES ASSIGNED

LOCATIONS	PRINT NAME/RATE	SIGNATURE* (UPON COMPLETION)
–14–	–15–	–37–

TIME SECURED –36–

*FINAL CHECKUP: WORK AREA AND ALL ADJACENT AREAS TO WHICH SPARKS AND HEAT MIGHT SPREAD WERE INSPECTED 30 MINUTES AFTER THE WORK WAS COMPLETED AND WERE FOUND TO BE FIRE SAFE. THE EQUIPMENT AND STRUCTURES WORKED ON WERE COOL TO THE TOUCH.

I CERTIFY THAT I AM FAMILIAR WITH AND WILL COMPLY WITH ALL SAFETY PRECAUTIONS PERTINENT TO THIS TYPE OF WORK.

HOT WORK OPERATOR SIGNATURE –16–

HOT WORK SUPERVISOR –17–

FIRE MARSHAL –18–

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TEST RESULTS

TESTS CONDUCTED AS REQUIRED		INITIAL TEST	1ST RETEST	2ND RETEST
OXYGEN		–19–	–38–	–53–
COMBUSTIBLE GAS		–20–	–39–	–54–
TOXIC TYPE:	–21–	–22–	–40–	–55–
TOXIC TYPE:	–23–	–24–	–41–	–56–
TOXIC TYPE:	–25–	–26–	–42–	–57–
TOXIC TYPE:	–27–	–28–	–43–	–58–

EXISTING CONDITIONS	INITIAL TEST	1ST RETEST	2ND RETEST
NOT SAFE FOR PERSONNEL/ NOT SAFE FOR HOT WORK	–29–	–44–	–59–
NOT SAFE FOR PERSONNEL WITHOUT PROTECTION/ NOT SAFE FOR HOT WORK	–30–	–45–	–60–
SAFE FOR PERSONNEL/ NOT SAFE FOR HOT WORK	–31–	–46–	–61–
SAFE FOR PERSONNEL/ SAFE FOR HOT WORK	–32–	–47–	–62–
NOT SAFE FOR PERSONNEL INSIDE/SAFE FOR HOT WORK OUTSIDE	–33–	–48–	–63–

NOTE: THIS INSPECTION INDICATES THE CONDITIONS WHICH EXISTED AT THE TIME TESTS WERE CONDUCTED.

GFE PERSONNEL SIGNATURE –34–

CO SIGNATURE, if required –35–

RECERTIFICATION

1ST RETEST/UPDATE

TIME: –49– DATE: –50– EXPIRES: –51–

GFE PERSONNEL SIGNATURE –52–

2ND RETEST/UPDATE

TIME: –64– DATE: –65– EXPIRES: –66–

GFE PERSONNEL SIGNATURE –67–

Figure 074-20-1. Navy Gas Free Certification and Test Log

Serial #_____

NAVY GAS FREE CERTIFICATION AND TEST LOG
CONTINUATION PAGE

CONTINUATION PAGE	
SHIP/UNIT/ACTIVITY:	-2-
ITEM/COMPARTMENT/SPACE:	-3-
ADDITIONAL VENTILATION INFORMATION:	
ADDITIONAL REQUIREMENTS/CONCLUSIONS PRESCRIBED PRECAUTIONS/INSTRUCTIONS:	

RETEST		
___ RETEST/UPDATE		
TIME:	DATE:	EXPIRES:
OFE PERSONNEL SIGNATURE:		
___ RETEST/UPDATE		
TIME:	DATE:	EXPIRES:
OFE PERSONNEL SIGNATURE:		
___ RETEST/UPDATE		
TIME:	DATE:	EXPIRES:
OFE PERSONNEL SIGNATURE:		

OPNAV 5100/16 (6/91)

TEST RESULTS				
TESTS CONDUCTED AS REQUIRED		RETEST	RETEST	RETEST
OXYGEN				
COMBUSTIBLE GAS				
TOXIC TYPE:				
TOXIC TYPE:				
TOXIC TYPE:				
TOXIC TYPE:				
TOXIC TYPE:				
TOXIC TYPE:				
EXISTING CONDITIONS		RETEST	RETEST	RETEST
NOT SAFE FOR PERSONNEL/ NOT SAFE FOR HOT WORK				
NOT SAFE FOR PERSONNEL WITHOUT PROTECTION/ NOT SAFE FOR HOT WORK				
SAFE FOR PERSONNEL/ NOT SAFE FOR HOT WORK				
SAFE FOR PERSONNEL, SAFE FOR HOT WORK				
NOT SAFE FOR PERSONNEL INSIDE/ SAFE FOR HOT WORK OUTSIDE				

Figure 074-20-1. Navy Gas Free Certification and Test Log (Cont'd)

1. Serial # (block 1)
2. Initial Certification (blocks 2 to 13)
3. Gas Free Related Hot Work (blocks 14-18 and 36-37)
4. Test Results (blocks 19-28, 38-43 and 53-58)
5. Existing Conditions (blocks 29-33, 44-48 and 59-63)
6. Recertification (49-52 and 64-67).

This certification and Test Log is a multi-use document. This certificate shall be used for all gas free evolutions, hot work having gas free requirements and as a log for record keeping purposes. For gas free evolutions, all blocks except those pertaining to hot work shall be utilized. For hot work having gas free requirements, all blocks shall be utilized.

The completed (original or legible copy) certificate shall be maintained as a legal document for 12 months. Prior to signing by the GFE/GFEA, all blocks pertaining to a particular evolution shall be completed (N/A if not applicable).

Block Instructions:

1. Serial # - locally assigned number. Begin serial numbers with the last two digits of the current calendar year, then use a dash mark and five additional digits starting with 00001 for the first serial number of the calendar year, i.e., 97-00001. On January first of 1998, start serial numbers over, i.e., 98-00001.
2. Ship/Unit/Activity - name, cleaning, welding, cutting, etc.
3. Item/Compartment/Space - specific equipment, compartment number and name of space, if applicable.
4. Type of Operation to be Conducted - i.e., cleaning, welding, cutting, etc.
5. Initial Date of Test, Hour - time test was conducted, i.e., 1600.
6. Initial Date of Test, Date - date test was conducted, i.e., 1996 May 07.
7. Initial Expiration, Hour - hour certification expires, i.e., 2300.
8. Initial Expiration, Date - date certification expires, i.e., 1996 May 07.
9. Ventilation Required: Yes/No - circle appropriate response.
10. Type - type of ventilation required, if Yes, is circled.
11. Inerted Gas - type of gas used in space/tank, if appropriate.
12. Pressed Up With - type of liquid used to press up space/tank, if appropriate.
13. Requirements/Conclusions/Prescribed Precautions/Instructions - any specific comments to set limitations or to clarify the certificate. Include all pertinent safety precautions, i.e., supplied-air respirators required, special clothing, etc.
14. Locations - specific location(s) of assigned fire watches.
15. Print Name/Date - fire watch name and date.
16. Hot Work Operator Signature - signature of person performing the hot work.
17. Hot Work Supervisor - signature of person designated as task supervisor.
18. Fire Marshal - signature of the ship’s FM.

NOTE

Use highest reading obtained in space for blocks 19-28, 38-43, 53-58.

19. Oxygen - oxygen as a percent for initial test.
20. Combustible Gas - combustible gas as a percent for initial test.
21. Toxic Type - indicate the name of toxic being tested.
22. Toxic Type, Initial Test - indicate result of test.
23-28. Toxic Type, Initial Test - same as 21 and 22.
29-33. Existing Conditions, Initial Test - check appropriate block as indicated by above tests.
34. GFE Personnel Signature - signature of GFE.
35. CO Signature - signature of CO, if required by ship's instructions.
36. Time Secured - time fire watch secured and left area.
37. Signature - signature of fire watch according to final checkup note.
38. Oxygen, 1st Retest - same as 19.
39. Combustible Gas - same as 20.
40. Toxic - same as 22.
41. Toxic - same as 24.
42. Toxic - same as 26.
43. Toxic - same as 28.
44-48. Existing Conditions, 1st Retest - same as 29-33.
49. 1st Retest/Update, Time - time of 1st retest/update, i.e., 0100.
50. 1st Retest/Update, Date - date of 1st retest/update, i.e., 1996 May 08.
51. 1st Retest/Update, Expires - time and expiration of 1st retest/update, i.e., 0300/1997 May 08.
52. GFE Personnel Signature - signature of gas free person doing 1st retest/update.
53. Oxygen - same as 19.
54. Combustible Gas - same as 20.
55. Toxic - same as 22.
56. Toxic - same as 24.
57. Toxic - same as 26.
58. Toxic - same as 28.
59-63. Existing Conditions, 2nd Retest - same as 29-33.
64. 2nd Retest/Update, Time - same as 49.
65. 2nd Retest/Update, Date - same as 50.
66. 2nd Retest/Update, Expires - same as 51.

67. GFE Personnel Signature - same as 52.

074-20.7 DEFINITIONS FOR EXISTING CONDITIONS

Following are the acceptable definitions for existing conditions found at the time gas free evolutions are conducted:

a. **NOT SAFE FOR PERSONNEL/NOT SAFE FOR HOT WORK.**When this category is marked on the gas free certificate:
   1. There is danger of poisoning due to toxic materials, vapors or gases present or likely to evolve under prevailing conditions, or danger of suffocation due to oxygen deficiencies.
   2. There is danger of fire or explosion due to the presence of flammable or explosive materials, vapors or gases or oxygen-enrichment present or likely to evolve under prevailing conditions.
   3. There is danger of fire, explosion or toxic hazards in the presence of hot work due to the existence of flammables, explosive or reactive residues, vapors, gases or oxygen-enrichment.
   4. There is danger of fire, explosion or toxic hazards in the presence of hot work as a result of unclean or improperly protected boundary spaces.

b. **NOT SAFE FOR PERSONNEL WITHOUT PROTECTION/NOT SAFE FOR HOT WORK.** This category is marked on the gas free certificate to provide a provisional approval for entry (for cleaning, valve closing or other procedure) when conditions are as follows:
   1. Toxic materials, vapors or gases may be present or may evolve in the space, but at levels less than IDLH and within the approved capacity of prescribed respiratory protective devices and other PPE.
   2. Flammable vapors may be present or may evolve but at levels less than ten percent of the LEL and where controls can be installed to maintain levels below ten percent of the LEL.
   3. There is danger of fire, explosion or excessive toxic levels in the presence of hot work in the space or from boundary spaces which have not been protected as required.
   4. Hot work is prohibited in the space or in the boundary spaces for which a provisional certificate is issued.

c. **SAFE FOR PERSONNEL/NOT SAFE FOR HOT WORK.** When this category is marked on the gas free certificate for a space:
   1. Toxic materials, vapors or gases do not or are not likely to exceed PEL; oxygen content is Safe for Personnel (19.5 percent to 22 percent).
   2. There is danger of fire or explosion or excessive toxicants in the presence of hot work due to flammable or explosive materials, vapors or gases in the space.
   3. There is danger of fire, explosion or excessive toxicants in the presence of hot work due to boundary spaces which have not been protected as required.

d. **SAFE FOR PERSONNEL/SAFE FOR HOT WORK.** When this category is marked on the gas free certificate:
   1. Toxic materials, vapors or gases do not or are not likely to exceed PEL; oxygen levels are Safe for Personnel (19.5 percent to 22 percent).
   2. All flammable materials, vapors or gases have been removed, are not likely to evolve or are controllable by ventilation.
   3. All surrounding boundary spaces have been protected as required.

e. **INERTED - NOT SAFE FOR PERSONNEL INSIDE/SAFE FOR HOT WORK OUTSIDE.** When this category is marked on the gas free certificate:

1. An inert medium has been introduced into the space, in the required concentration to achieve a nonflammable atmosphere, and will be maintained continuously to ensure proper inert atmospheres.
2. Oxygen levels in the space will not support combustion or life.

The oxygen level in an inert space shall be monitored to maintain not more than one percent oxygen in the space.

3. Required measures have been taken to isolate the space and ensure that isolation is maintained until the inerting medium is removed. Block 11 of the gas free certificate, as illustrated in Figure 074-20-1, shall contain the type of gas used to inert the space.

Resort to pressing-up only in emergencies when spaces cannot be cleaned and gas freed normally, as described in Section 23, and cannot be gas inerted, as described in paragraph 074-24.3.

f. **PRESSED-UP WITH - NOT SAFE FOR PERSONNEL INSIDE/SAFE FOR HOT WORK OUTSIDE.** When this category is marked on the gas free certificate, the space is pressed-up to eliminate flammable atmospheres. Block 12 of the gas free certificate, as illustrated in Figure 074-20-1, shall contain the type of liquid used to press-up with. This indicates that:

1 The space has been entirely filled with non-hazardous liquid, usually water.

2 Means have been provided to verify the liquid level and the absence of air or vapor pockets.

3 Boundary spaces have been protected as required.

074-20.8 DISTRIBUTION

Distribution of gas free engineering certificates is as follows:

a. The original shall be retained for GFE's files.

b. One legible copy shall be posted at all other access areas which are open or readily accessible to personnel.

c. One legible copy shall be posted at the main entrance or most commonly used access to the space.

d. One legible copy shall be provided to the department or division requesting the gas free service.

e. One legible copy shall be provided to DC Central.

f. One copy shall be provided to the OOD.

074-20.9 RETESTING AND RECERTIFYING SPACES

When there may be a significant change in the conditions within a confined space, the space shall be retested and recertified. The results of retesting will be written on the original and all copies of the certificate. The GFE/GFEA may determine that a new certificate is required before entry or work. Such changes may include:

a. Entry or work delay after issue of certificate.

b. Expiration of the time limit of the certificate without any retesting and updating of the certificate.

c. Detection of hazards sufficient to warrant stopping operations and removing personnel.

d. Introduction into the space of new operations or materials that were not noted on the initial certificate.

e. Closing the space during temporary shutdown and reopening the space for resumption of work.

f. Securing the ventilation system within a space during temporary work shutdown.

g. Increases in temperature may cause combustible or flammable liquid to volatize at a faster rate.

h. Ship movement.

074-20.10 SIGNAGE

The GFE/GFEA may elect to post appropriate signs to identify the following three types of confined spaces:

a. IDLH (red, black & white diamond grid with black and white letters)

b. Spaces for which gas-free certificate is required for entry (red, black & white diamond grid with black and white letters)

c. Spaces for which a gas-free certificate is not required for entry (green background with white lettering).

Examples of approved signage are shown in Appendix I and are available as open purchase from 3-M Corporation.

SECTION 21
VENTILATION

074-21.1 INTRODUCTION

Flammable, toxic or oxygen-deficient or -enriched atmospheres in confined spaces are a consequence of inadequate natural or mechanical ventilation. Temporary ventilation using portable fans or blowers can limit hazards to an acceptable level. Ship configuration, availability of portable blowers and duct limits can restrict ventilation. Because of these limitations, protect personnel with appropriate respiratory equipment even when ventilation is provided.

074-21.2 BASIC VENTILATION OBJECTIVES

The objectives of ventilation are to:

a. Remove contaminated air (flammable or toxic) from the space, limit flammable atmospheres to ten percent or less of the LEL and limit toxic concentrations to the PEL.

b. Capture and remove contaminants generated by operations within the space or dilute such airborne contaminants to safe concentration levels.

c. Provide fresh, breathable air for health and general comfort.

Ventilation evaluation must compare ventilation system capacity with the atmosphere of the space. This section sets forth minimum requirements and provides additional ventilation guidance for confined spaces. Ventilation provided for any given operation (even though it may be less than the levels prescribed in this section) is acceptable if test and evaluation show prescribed levels of clean breathable air and appropriate levels of flammables.

074-21.3 VENTILATION BEFORE ENTRY OR WORK

Prior to any ventilation, the GFE must determine if the space presents an upper explosive limit (UEL) danger. Explosimeters will not be able to determine UEL reliably. This determination shall be made prior to access by checking DC plates or ship’s drawings, as appropriate, for fuel sources (i.e., JP-5, DFM, sewage piping, fuel tank tops) and heat sources such as steam lines. If a UEL condition or the potential exists, have appropriate firefighting assets standing by. Proceed with caution. Secure the heat or fuel source as the situation dictates and rig grounded exhaust ventilation.

NOTE

There will be a minimum of two air changes prior to entry into a confined space unless installed ventilation is in operation.

Confined spaces shall be ventilated before entry or work, until flammable atmospheres are less than ten percent of the LEL, toxic atmospheres are controlled and oxygen content is as required by **NSTM Chapter 074, Volume 3,** Section 20.

074-21.4 VENTILATION TYPES

Ventilation requirements for entry into and work in confined spaces are dependent upon the nature of the space, the contents and the operations to be conducted within the space. For purposes of gas free engineering, requirements will be considered for general ventilation, dilution ventilation and local exhaust ventilation. Operations conducted within a confined space may require the application of a single type of ventilation such as general ventilation or may require the application of two types such as general ventilation combined with a local exhaust system.

074-21.4.1 GENERAL VENTILATION. General ventilation may be utilized in a confined space to provide uncontaminated air for breathing and to maintain general comfort of personnel. It may also be used to maintain concentrations of toxic and flammable atmospheres at acceptable levels where the sources of such contaminants are small and evolution of airborne contaminants is low. The accepted practice and the required level established by the Naval Bureau of Medicine and Surgery for general ventilation is one complete air change every three minutes. Therefore, a 30,000 cubic-foot space requires a general ventilation rate of 10,000 cubic feet per minute (ft^3 /min).

074-21.4.2 CALCULATING GENERAL VENTILATION. General ventilation is calculated as follows:

1. Find volume of the space (H x W x L = Vol) as expressed in cubic feet.
2. Divide volume of space by capacity of blower (vol/number of blowers) which is the maximum amount of time to complete one air change of the space, to derive an answer of how many blowers will be required to meet the general ventilation requirement.
3. Divide the minutes as derived from step 2 above by the number 3 (Time/3 = number of blowers) which is the maximum amount of time to complete one air change of the space, to derive an answer of how many blowers will be required to meet the general ventilation requirement.
4. If the final answer is expressed as a decimal or fraction, then you must round up to the next whole number. This will be how many blowers will be required to meet general ventilation requirements. Calculation example:
   a. The space is 20 ft x 35 ft x 10 ft - 7,000 ft^3
   b. The blower to be used is rated at 2,000 cubic feet per minute; 7,000 ft^3 divided by 2,000 CFM = 3.5 (min)
   c. Next, 3.5 (min) divided by 3 (gen. vent. reqs) = 1.166 (# blowers)
   d. Next, round **up** 1.166 (# blowers) to the next whole number. Final answer should be ″2″ blowers.

074-21.4.3 LOCAL EXHAUST VENTILATION. Local exhaust systems contain an exhaust intake (duct opening or hood) positioned 6 to 10 inches from the work which generates airborne contaminants. For local exhaust

to be effective, the part of the work zone farthest from the exhaust inlet needs an airflow of 100 linear ft/min toward the exhaust inlet. This arrangement captures airborne contaminants as they are generated, draws them into the system duct work and removes them. Local exhaust systems are most effective for removing airborne contaminants generated from operations such as welding or localized solvent cleaning.

074-21.4.4 DILUTION VENTILATION. Dilution ventilation is established by using portable ventilation equipment. By drawing air out of the space and replacing the stagnant air with fresh air drawn in by natural air circulation, the contaminated air within the space may be diluted to a safe level. Dilution ventilation is not as effective in contaminant control as local exhaust ventilation but may be required for certain types of operations (i.e., spray finishing) which cannot be effectively controlled with a local exhaust system. Dilution ventilation requirements may be calculated based on the airborne contaminant generation rate, the required level or percentage of LEL and the LEL of the contaminant involved. (See paragraph 074-21.8) In shipboard (afloat) operations, dilution ventilation will generally be used for the control of flammable, oxygen-deficient or -enriched atmospheres rather than for control of toxicants because too much air will be required to dilute toxicants to PEL. Dilution ventilation may require the use of supplied air respiratory protection when toxics are being generated.

074-21.5 VENTILATING FLAMMABLE ATMOSPHERES

Fans, blowers, motors and other such equipment utilized to ventilate atmospheres containing flammable or explosive vapors, fumes, mists or dusts shall be approved, explosion-proof equipment or intrinsically safe equipment, such as portable blowers jet air movers or steam eductors. Equipment shall be bonded and grounded to control static electricity accumulation and discharges. Additional guidance for fans and ventilation can be found in **NSTM Chapter 512, Fans**.

074-21.6 VENTILATION SYSTEM COMPONENT PLACEMENT

Good ventilation systems provide clean, breathable makeup air to replace contaminated air. Correct and incorrect ventilation component placement is shown in Figure 074-21-1. Additional guidance for fans and ventilation can be found in **NSTM Chapter 512, Fans**.

074-21.6.1 INLET LOCATION. The placement of exhaust duct inlets and make-up air inlets is extremely important to achieve proper air distribution in a confined space. Do not place an exhaust fan in the top of a deep, single-opening confined space (where makeup air enters through the same opening) which can cause short circuiting, when the fan exhausts most of the make-up air as soon as it enters. Improve the distribution of air by extending a duct to the exhaust inlet from the bottom or back of the space. Air distribution and circulation will be improved when air entry and exhaust are accomplished through separate openings. Where make-up air and exhaust move through the same opening (such as a doorway), provide ducting to carry exhaust air away from the inlet and to prevent recirculation of contaminated air.

074-21.6.2 EXHAUST OUTLET LOCATIONS. Always vent exhaust outlets carrying flammable or toxicants to the exterior of the ship where airborne contaminants can disperse. Prohibit the placement of exhaust outlets where exhaust air could contaminate adjacent spaces, accumulate or pocket in low areas or expose personnel to dangerous atmospheres. Additional blowers may be positioned separately near the exhaust outlet to assist in the dispersion of gases into the atmosphere and the blowing of exhausted contaminated gases away from personnel and ventilation make-up air inlets.

074-21.6.3 DUCT LOCATIONS FOR CONTAMINANTS LIGHTER OR HEAVIER THAN AIR. Airborne contaminants which are lighter or heavier than air tend to accumulate to dangerous levels in the highest or lowest areas, respectively, of a confined space. Such concentrations affect the placement of exhaust and makeup air

vents. When airborne contaminants are heavier than air, place the exhaust inlet near the bottom of the space and the make-up air inlet at the top of the space. When contaminants are lighter than air, or elevated temperatures cause contaminants to rise, reverse the placement, with the exhaust inlet at the top of the space and the makeup air inlet at the bottom. The ventilation system will thus capture and remove the airborne contaminants at the point of greatest concentration with the least dispersal of the airborne contaminants. See Figure 074-21-1, views 6 and 7.

074-21.6.4 BLOWING VERSUS DRAWING AIR.

Never blow air into a space which contains flammable or toxic particles or atmospheres.

Blowing air into a space agitates, evaporates and disperses the airborne contaminants. Blowing air into a space also forces uncontrolled airborne contaminants from the space through any available openings and may contaminate adjacent areas. Drawing air from the space may be less efficient but it controls particle capture and removal. Air may be blown into a space only when no flammable or toxic materials are present or are being generated by the work process and ventilation is required only to provide clean, respirable air for breathing and general comfort.

074-21.6.5 FAN LOCATION. Exhaust fans or blowers shall be located in a duct outlet on the weather deck, whenever possible, so the exhaust ducts within the ship are under negative pressure. Locating fans or blowers at the exhaust inlet will result in a positive pressure on exhaust ducts and potential leakage of flammable or toxic atmospheres into other ship spaces. See Figure 074-21-1, view 8. Duct work, located on the interior of the ship, can be sealed at all connections by using duct tape wrapped three times (minimum) to prevent separation of connections or the leakage of toxic gases into the interior of the ship at the connections.

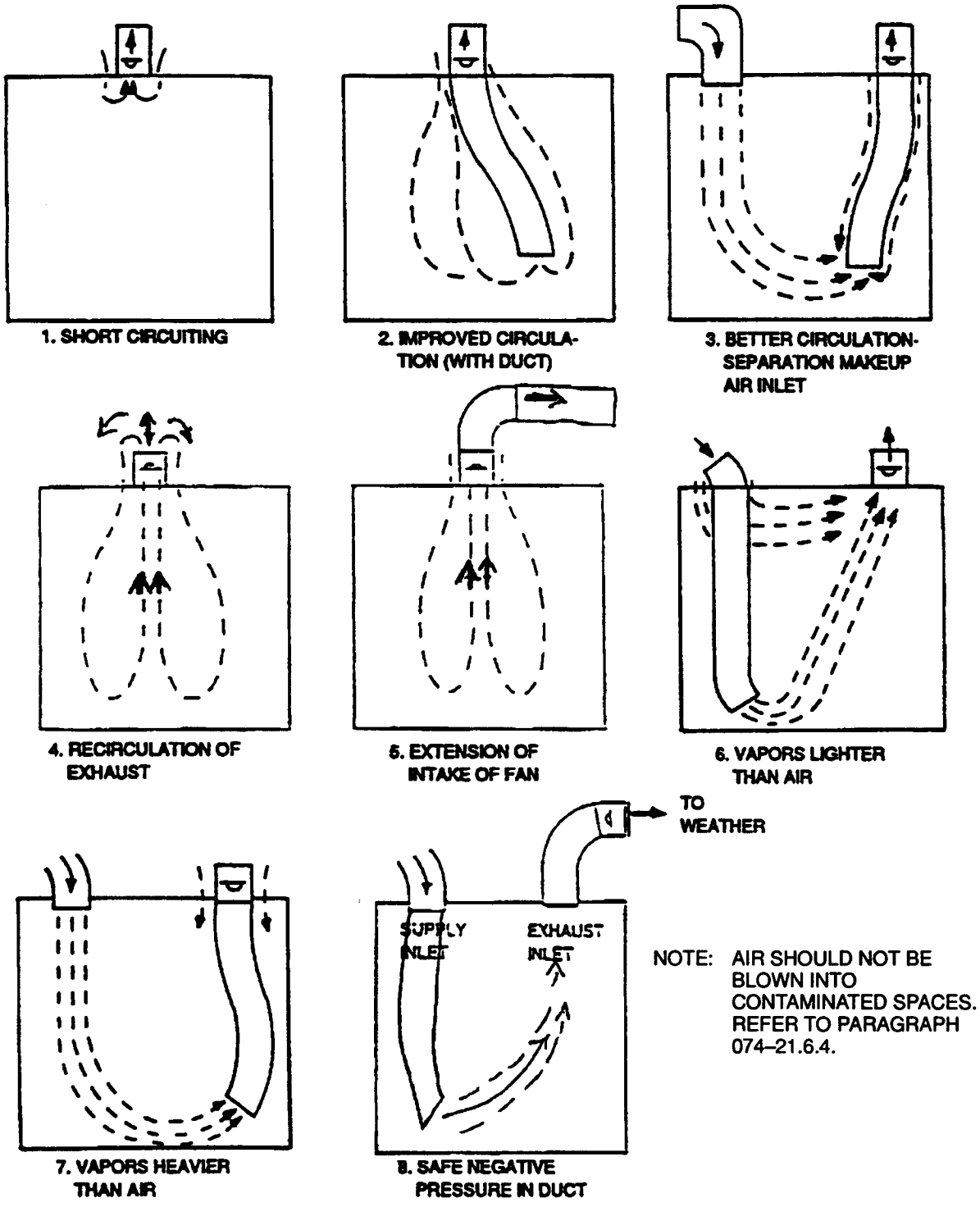

Figure 074-21-1. Ventilation Component Placement

074-21.6.6 DUCTING. The size, type and length of ducting used affects the air movement capacity of fans and blowers. Navy standard portable ventilation ducting (i.e., 8 inch or 10 inch trunk/vent hoses) has a high coefficient of friction; this severely limits ducting lengths. Increasing the length of the duct reduces the air velocity in the duct and increases the pressure loss due to friction. No more than three 15-foot sections of hose assembly/air duct should be used with each fan, but a longer system may be contrived by arranging two or more fans with tubing in series.

A duct air flow velocity of 2,000 to 4,000 feet per minute (ft/min) will capture the contaminants and minimize friction loss, fan loss, noise and reduce the possibility of residue settling in the ducting.

See **NSTM Chapter 512, Fans**, for additional guidance in the selection and use of fans and ducting.

074-21.7 VENTILATION REQUIREMENTS FOR SPECIFIC OPERATIONS

Ventilation minimums for certain operations are provided for guidance. Observing minimum ventilation requirements does not necessarily eliminate flammable or toxic hazards. The effect of ventilation on flammables, toxicants and breathable air may be determined only by studying actual samples of the atmosphere within the space. For example, dilution ventilation may be used to maintain flammable vapors at a concentration of less than ten percent of the LEL but the ventilation may not be sufficient to dilute the airborne contaminant to acceptable personnel exposure levels. In such cases, ventilation shall control flammable vapor concentrations, while approved respiratory protective devices protect personnel from toxic exposures. The GFE, GFEA or GFEPO shall perform tests, measurements, samples and evaluations appropriate to the nature of the operation and the airborne contaminants.

074-21.7.1 VENTILATION REQUIREMENTS FOR WELDING, CUTTING, BURNING AND BRAZING. Ducting shall be flexible, noncombustible and free of combustible residue. For additional ventilation requirements refer to paragraph 074-21.7.3.

074-21.7.2 LOCAL EXHAUST VENTILATION. Welding, cutting, burning, brazing or similar operations conducted within confined spaces require local exhaust ventilation, whenever possible, to capture and remove airborne contaminants. For local exhaust to be effective, the part of the work zone farthest from the exhaust inlet needs an airflow of 100 linear ft/min toward the exhaust inlet. Capture velocities decrease drastically as the distance increases between the exhaust inlet at the point of operation and the exhaust outlet. Use flanged exhaust inlets which are approximately 25 percent more efficient than unflanged inlets.

Always supply personnel with NIOSH-approved respiratory protection equipment (for example, SCBA or SAR/SCBA) for working with highly toxic materials since even slight ventilation system trouble may result in significant personnel exposure. OPNAVINST 5100.19 (series), NAVOSH Program Manual for Forces Afloat, provides detailed information.

074-21.7.3 TOXIC METALS VENTILATION. Highly toxic metals, or certain other materials, may require greater supply and exhaust airflows to capture airborne contaminants. These precautions apply to such known toxic metals, materials and processes as fluorine compounds, zinc, lead, mercury, beryllium, cadmium, iron powder, halogenated hydrocarbons, cleaning and degreasing compounds, stainless steel welding involving chemical flux and gas shielded arc welding.

074-21.7.4 DILUTION VENTILATION. When effective local exhaust ventilation is impossible due to the nature of the space or other factors, provide dilution ventilation. Dilution ventilation seldom protects the welder completely because of the uneven production of airborne contaminants, unknown amount of contaminant generated and high volumes of dilution air required. Dilution ventilation does, however, provide a controlled means of diluting, collecting and removing contaminated air from the space. Ensure that adjacent areas and spaces are protected and that exhaust discharges are filtered if necessary and dispersed to the exterior of the ship.

074-21.7.4.1 Dilution Ventilation Volume Formula. Estimated dilution ventilation volume needs as follows:

Allowing one air change every 3 minutes but not less than:

a. 2,000 cubic feet per minute (ft^3 /min) per welder, if a 5/32 inch or 3/16 inch rod is used.

b. 3,500 ft^3 /min per welder, if a 1/4 inch rod is used.

c. 4,500 ft^3 /min per welder, if a 3/8 inch rod is used.

Example: Welding is to be done in a tank that is 15 feet by 20 feet by 9 feet with one welder using a 5/32 inch rod. The material to be welded is steel. To calculate the volume required for one air change every 3 minutes, in ft^3 /min:

Dilution ventilation volume

= Volume of the space/3 minutes

= 15’ x 20’ x 9’/3 minutes

= 2,700 ft^3 /3 minutes

= 900 ft^3 /minute

However, due to the 5/32 inch welding rod being used, the minimum dilution air flow volume in this case is 2,000 ft^3 /min. Thus, two 1,000 ft^3 /min portable fans with individual exhaust ducts will be required to exhaust air and remove fumes and hazardous gases generated. The duct will extend into the space as shown in Figure 074-21-1, views 2 and 3. If the space has two access openings, the arrangement for makeup air, shown in Figure 074-21-1, view 3, is preferred.

074-21.7.4.2 Dilution Ventilation Velocity Formula. An example of the velocity formula follows:

The face velocity at each of the 8-inch exhaust ducts, required to maintain a 2,000 ft^3 /min exhaust rate required in paragraph 074-21.7.4.1, will be:

Q = Dilution volume flow rate in ft^3 /min required per blower.
A = Area of the duct opening, in square feet (Areas for common duct diameters are listed in Figure 074-21-1).
V = Face velocity of air at duct inlet
Q = AV
V = Q/A
V = (1,000 ft^3 /min) /0.35 sq ft

Duct Diameter in Inches	Duct Opening Area* Square Feet
6	0.20
8	0.35
10	0.55
*Area = $\frac{\pi d^2}{4} \div 144$, when d is expressed in inches.	

Figure 074-21-2. Duct Diameter Opening Area

V = (approx.) 2,860 ft/min at **each** exhaust duct inlet
Thus, air flow measurement at the face of each duct is approximately 2,860 ft^3 /min to maintain one complete air change every three minutes.

NOTE

If actual measured air velocity at each exhaust duct inlet opening is less than 2,860 ft^3 /min, a larger capacity portable fan may be used, or the length of exhaust duct can be reduced until a velocity of 2,860 ft^3 /min is attained.

074-21.7.5 VENTILATION REQUIREMENTS FOR PAINTING, COATINGS AND USE OF SOLVENTS. Paint and preservative coating removers, cleaning solvents, liquid vehicles for paints, preservative coatings and similar materials are frequently toxic and flammable. When these materials are used in confined spaces, ventilation will be required to control the hazards. Generally, airborne contaminants from these operations are dispersed over a wide area rather then at a single point; therefore, local exhaust ventilation is not effective. Use dilution ventilation to ensure that adjacent areas are protected and that exhaust discharges are filtered to remove and disperse airborne contaminants to the outside atmosphere. Refer to **NSTM Chapter 631, Volume 2, Preservation of Ships in Service, Surface Preparation and Painting,** for further guidance.

NOTE

Because it is difficult to assess whether ventilation has diluted the atmosphere to the PEL, equip personnel with NIOSH-approved respiratory devices (paragraph 074-19.8). Refer to OPNAVINST 5100.19 (series) for list of appropriate respirators.

074-21.7.6 DILUTION FOR SPRAY PAINTING. In operations such as spray painting, flammable concentrations will exist at some point within the cone-shaped spray emanating from the spray nozzle. These concentrations are not cause to discontinue operations. Rather, determine the effect of dilution ventilation on the total atmosphere within the space. Where flammable concentrations exist at significant distances outside the spray cone, take the actions described in paragraph 074-21.7.5.

074-21.8 DILUTION TO LEL

Ventilation shall dilute contaminants to ten percent or less of the LEL for the material involved. Ventilate continuously during operations and afterward until flammable materials have evaporated and the space is gas free. Test as necessary to monitor the conditions within the space during operations. When concentrations of flam-

mable vapors reach or exceed ten percent of the LEL, stop operations until ventilation deficiencies have been corrected. Conduct final test of the space after the ventilation system has been secured for at least ten minutes. In addition, the final test shall include a toxic test for carbon monoxide.

074-21.9 DILUTION VENTILATION FLOW RATES

Flow rates for dilution ventilation to maintain exposure levels at ten percent of the LEL shall be calculated by this formula:
Q = (C(100-LEL))/LEL x Vv x gal/min
X % of solvents expressed as a decimal
Q = Dilution volume flow rate in cubic feet per minute (ft^3 /min or cfm).
C = 10 (C is a constant used to limit the flammable atmosphere to ten percent of the LEL.)
LEL = Lower Explosive Limit. The LEL's for typical solvents used in paints, preservative coatings and cleaning compounds are given in Figure 074-21-3, LEL's and Vapor Volume of Some Commonly Used Solvents.
Vv = Vapor volume in cubic feet of vapor per 1 gallon of liquid. The Vv values for typical solvents used in paints, preservative coatings and cleaning compounds are given in Figure 074-21-3.
Gal/min = Number of gallons of solvent used per minute.
% of solvents = Amount of different solvents which make up a particular paint.
Example: A paint containing 8 percent xylene (o) and 45 percent toluene as carrier solvents is used at the rate of 1 gallon every 5 minutes.
O xylene
/min
x % of solvents expressed as a decimal
= (10(100-1.0))/1.0 x 26.4 ft^3 /1 gal
x 1 gal x 0.080 xylene/5 min
= 990 x 26.4 ft^3 x 0.016/min
= (approx.) 418 ft^3 /min
Q toluene
= (C(100-LEL))/LEL x Vv x gal/min
x % of solvent
= (10(100-1.4))/1.4 x 30.4 ft^3 /1 gal
x 1 gal x 0.45 toluene/5 min
= 704.3 x 30.4 ft^3 x 0.090/min
= (approx.) 1,927 ft^3 /min
Total required
= Xylene + Toluene
= 418 ft^3 /min + 1,927 ft^3 /min
= 2,345 ft^3 /min

Solvent	Cubic Feet of Vapor Per Gallon of Liquid at 70°F (21.1°C) (Vv)	Lower Explosive Limit in Percent by Volume of Air at	
		70°F (21.1°C) (LEL)	212°F (100°C) (LEL)
	Column 1	Column 2	Column 3
Acetone	44.0	2.6	
Amyl acetate (iso)	21.6		1.0
Amyl alcohol (n)	29.6	1.2	
Amyl alcohol (iso)	29.6	1.2	
Benzene	36.8		1.4
Butyl acetate (n)	24.8	1.7	
Butyl alcohol (n)	35.2	1.4	
Butyl cellosolve	24.8	1.1	
Cellosolve	33.6	1.8	
Cellosolve acetate	23.2	1.7	
Cyclohexanone	31.2		1.1
1,1 Dichloroethylene	42.4	5.6	
1,2 Dichloroethylene	42.4	9.7	
Ethyl acetate	32.8	2.5	
Ethyl alcohol	55.2	4.3	
Ethyl lactate	28.0		1.5
Methyl acetate	40.0	3.1	
Methyl alcohol	80.8	7.3	
Methyl Cellosolve	40.8	2.5	
Methyl ethyl ketone	36.0	1.8	
Methyl n–propyl ketone	30.4	1.5	
Naphtha (VM&P) (76°F Naphtha)	22.4	0.9	
Naphtha (100°F Flash) Safety Solvent–Stoddard Solvent	23.2	1.1	
Propyl acetate (n)	27.2	2.0	
Propyl acetate (iso)	28.0	1.8	
Propyl alcohol (n)	44.8	2.1	
Propyl alcohol (iso)	44.0	2.0	
Toluene	30.4	1.4	
Turpentine	20.8	0.8	
Xylene (o)	26.4	1.0	

Figure 074-21-3. LELs/Vapor Volume of Some Commonly Used Solvents

Thus explosion-proof blowers may be used to exhaust air from the space to achieve the ten percent LEL requirement. To minimize pressure loss, air turbulence and noise in the duct, five 8-inch-diameter ducts will be used. The 8-inch ducts will extend into the space as shown in Figure 074-21-1, views 2 and 3. If the space has two access openings, the arrangement for makeup air shown in Figure 074-21-1, view 3, is preferred.

NOTE

The control of flammable atmospheres to ten percent of the LEL shall be determined by direct measurement of the atmosphere using approved instruments.

SECTION 22
HOT WORK

074-22.1 INTRODUCTION

Section 22 applies to all hot work performed in confined spaces, machinery rooms, catapult rooms, bilges and other locations proximate to flammable atmospheres (i.e., near fuel tank vents and sounding tubes). This section also applies to hot work performed on closed structures or containers such as pipes, drums, ducts, tubes, jacketed vessels and similar items. When hot work involves inerting, pressing-up or steam blanketing, refer to Section 24.

Requirements for general hot work or spark producing operations performed in open or well-ventilated areas are located in **NSTM Chapter 074, Volume 1** and OPNAVINST 5100.19 (series). These operations generally do not require gas free engineering and are allowed by issuance of a Hot Work Permit by a FM, vice the gas free certificate issued by a GFE/GFEA. The FM will refer hot work requests to the GFE/GFEA when inspection shows gas free engineering may be required.

074-22.2 HOT WORK DEFINED

CAUTION

When open flame or heat-producing work such as welding, cutting or brazing is to be conducted, the worksite is to be inspected by the GFE or FM regardless of location, paragraph 074-22.2 notwithstanding.

Hot work in the context of gas free engineering includes:

a. Flame heating, welding, torch cutting, brazing or carbon arc gouging.

b. Any operation producing temperatures of 204.4°C (400°F) or higher. Temperatures are shown as degrees centigrade. Metric Conversion Charts are provided in Appendix J.

c. Any operation occurring in the presence of flammable materials or in a flammable atmosphere which requires the use or presence of an ignition source. Examples of such work include spark-producing or arc-producing tools or equipment, static discharge, friction, open flames or embers, impact, non-explosion-proof equipment such as lights, fixtures or motors.

074-22.3 CLEANING AND VENTILATING FOR HOT WORK

Before hot work is begun in a confined space, the space shall be tested, inspected, emptied of flammable cargo, cleaned and ventilated as required by this publication and certified Safe for Hot Work. Extraneous flammable or combustible materials such as scrap wood, paper, ropes or rags shall be removed from the space. Combustible materials that cannot be removed shall be adequately protected. Ventilation ducting shall be made of noncombustible metal, of flexible construction and free from hazardous combustible residues. See Section 21 for specific ventilation procedures.

074-22.4 FIRE WATCH

When open flame or heat-producing work such as welding, cutting or brazing is to be conducted in the absence of combustible materials or flammable residues, establish a trained fire watch at the worksite. When hot work may transmit fire hazards to other spaces by overheating the connecting deck, overhead or bulkhead, provide fire watches on both sides of the hot deck, overhead or bulkhead. Fire watch communications will enable the fire watch to report hazardous conditions on the opposite side of separating structures and provide a signal to stop hot work. Fire watches on both sides of the separating structure shall have, and know how to use, fire extinguishing equipment suitable to the exposure. Fire watches shall be equipped with PPE as required for the operation being conducted (i.e., goggles or helmet, NIOSH-approved respiratory protection equipment, fire retarding clothing). After completion of the hot work operation, fire watches shall remain on station for a minimum of 30 minutes, ensure the area is cool to the touch and that no smoldering embers remain. Refer to **NSTM Chapter 074, Volume 1, Welding and Allied Processes** for definition, classes of hot work, fire watch requirements, training and fire prevention cautions.

074-22.5 FIRE EXTINGUISHING EQUIPMENT

Fire extinguishing equipment shall be provided which is suitable for the nature and amount of flammables or combustibles present.

Never use vaporizing liquid extinguishers in confined spaces.

a. Use Purple-K-Powder (PKP), carbon dioxide (CO_2) and AFFF extinguishers only after determining that the extinguisher is appropriate for the exposure. Also determine whether the displacement of oxygen by discharge of CO_2 into the space is likely to cause a hazard to personnel.

b. Water extinguishers or firehoses equipped with vari-nozzles, fog nozzles or fog applicators are the most suitable fire extinguishing equipment for hot work in the presence of ordinary (Class A) combustible material, or flammable residues, coatings or insulation.

c. Evaluate fire extinguishing equipment for:
   1. Ability to suppress the fire.
   2. Hazards that the extinguishing agent might create in the space.
   3. Capacity of the equipment compared to the fire potential. Firehoses equipped with a vari-nozzle, fog nozzle or applicator or portable fire extinguishers are acceptable. The nature of the space or ship may restrict selection of fire equipment.

Class A combustibles are those which leave embers and must therefore be cooled throughout the entire mass (**NSTM Chapter 555, Volume 1, Surface Ship Firefighting**).

074-22.6 HOT WORK LOCATIONS

Prior to beginning hot work, an assessment of potential hazards must be made at each location. The following, although not all-inclusive, provides guidance regarding what hazards to expect.

074-22.6.1 BOUNDARY SPACES. When hot work is to be performed on fuel tanks, associated vent spaces or other spaces containing flammables (i.e., paint lockers, flammable liquid storerooms), the adjacent spaces above, below and on all sides (boundary spaces) shall first be inspected and tested, cleaned and ventilated or inerted as appropriate, then certified Safe for Hot Work.

074-22.6.2 PIPES, TUBES, COILS. Hollow connections to a space can present the same hazards as the space itself.

a. Pipes, tubes, coils or similar items which service, enter or exit a confined space shall be flushed, blown, purged or otherwise cleaned and certified Safe for Hot Work before the performance of hot work on such items. If not so treated and certified, the certificate for the space shall be marked Not Safe for Hot Work.

b. Valves to pipes, tubes or similar items shall be closed, the pipes blanked off and tagged out, following the provisions of the Ship's Tagout Bill, to prevent inadvertent discharge or backflow of materials into the space.

074-22.6.3 HOT WORK ON CLOSED CONTAINERS OR STRUCTURES. Prior to beginning hotwork on hollow structures, drums, containers, jacketed vessels or similar items, the items shall be cleaned, flushed, purged, inerted, filled with water or otherwise made safe. The items shall be inspected, cleaned, tested and certified before performing hot work. Items which are closed and subject to pressure build-up from any application of heat shall be vented to relieve any pressures created by the hot work. The method of venting shall be selected to prevent ignition or explosion during the venting process. When vent holes must be drilled, the requirements of paragraph 074-24.3.1 shall be followed.

074-22.6.4 HOT WORK NEAR PRESERVATIVE COATINGS. Characteristics of a particular coating determine the procedures and precautions for hot work near that coating.

a. Flammable Coatings. Flammable coating hot work requirements are as follows:
   1. Determine the flammability of coatings before starting hot work by referring to **NSTM Chapter 631**, MSDS's and other written documentation, as needed. Remove combustible coatings from the hot work area to a distance sufficient to prevent ignition or offgassing (from temperature increase), at least 4 inches on all sides from the outer edge of the hot work.
   2. When stripping flammable coatings, never use a flame or other type of heating device which allows the coating to be heated to a temperature resulting in the production of smoke.
   3. Test continuously for flammable atmospheres during hot work. Where significant offgassing is detected, stop hot work and further strip the coating. Start artificial cooling methods, such as wetting down, to prevent temperature increases in the unstripped areas.
   4. Shield flammable coatings from slag or sparks in the area of the hot work. Wet down surrounding areas or cover with netted fire retarding cloth conforming to MIL-C-24576, if appropriate.
   5. Ventilate in accordance with Section 21.
   6. At a minimum, keep a 1-1/2 inch firehose with a vari-nozzle, fog nozzle or fog applicator in the immediate vicinity, charged and ready for instant use, except where prohibited by nature of the space or ship.

b. Before hot work, strip any coatings which become toxic when heated to at least four inches beyond the area

that will be heated. Equip personnel with airline respirators approved by NIOSH or equivalent respiratory protection in accordance with OPNAVINST 5100.19 (series). Ventilate in accordance with Section 21 to remove toxic vapors or fumes from the space.

074-22.6.5 HOT WORK NEAR DAMAGED SURFACES. Tank walls and coating deformities may carry toxicants and other hazards.

Blisters, scales and similar formations inside tanks that have held flammable materials may, even after cleaning and ventilating, hold flammable residues. Plan hot work carefully, considering the following:

a. Ascertain whether any previous tank contents may have left hazardous residues.

b. Assess the possibility of a surface flash which would involve the entire space.

c. Clean scales or blisters:
   1. Remove scales or blisters which contain highly flammable residues (flashpoint 37.8°C [100°F] such as gasoline or JP-4 fuel) from the entire space before hot work.
   2. Clean away scales or blisters containing less flammable residues (flashpoint above 37.8°C [100°F] such as fuel oil or JP-5 fuel) to a distance of four inches on all sides from the outer edge of the hot work. In all cases, the area cleaned shall be sufficient to prevent offgassing from surrounding areas and to prevent ignition of residues.
   3. Clean or protect areas below the hot work; use screens, devices to capture sparks and slag, fire retarding cloth conforming to MIL-C-24576 or similar measures.

d. Wet down areas around hot work to reduce the residue vaporization and to prevent small fires and flashes.

e. Assign fire watches with equipment to extinguish any resulting fire (see paragraph 074-22.4).

074-22.6.6 HOT WORK NEAR PRESSURIZED SYSTEMS.

When subjected to high temperatures, hydraulic fluid can decompose and produce highly toxic by-products. Noncombustible insulation such as fiberglass may have combustible backing or adhesive materials.

Before beginning hot work, depressurize nearby pressurized systems (such as hydraulics or Freon). Protect piping, fittings, valves and other system components from contact with flames, arcs, hot slag or sparks. Clean space and remove contaminants (and substances such as hydraulic fluid) before hot work.

074-22.6.7 HOT WORK NEAR INSULATION. Conduct hot work carefully near combustible insulation. All submarine anti-sweat hull insulation materials will burn and will produce highly toxic and irritating combustible gases. Some insulation materials may be ignited by welding slag or other short-duration exposure to ignition sources. Foam insulation materials are particularly likely to ignite and generate toxic combustion products. The following are procedures for hot work near insulation:

Insulation may contain asbestos. Removal of asbestos insulation from the area of hot work shall be conducted in accordance with OPNAVINST 5100.19 (series).

a. Remove insulation from the area of hot work.

b. Wet down non-removable insulation with water then cover the insulation with water-soaked, fire-retarding cloth.

c. Station a fire watch with a charged 1-1/2 inch firehose, ready for use in the immediate area.

074-22.6.8 HOT WORK NEAR AMMUNITION AND EXPLOSIVES. Hot work in the area of magazines or near ammunition or explosives shall follow provisions of NAVSEA OP-4, **Ammunition Afloat**.

074-22.7 HAZARDOUS BY-PRODUCTS

Welding, cutting or burning in the presence of certain materials (such as hydraulic fluids, Freons, chlorinated solvents or halons) or heating such materials can cause decomposition and produce hazardous by-products. Ensure that hot work is not conducted on or near such materials. Keep welding or cutting operations which produce high levels of ultraviolet radiation at least 200 feet from exposed chlorinated solvents.

074-22.8 GAS WELDING AND CUTTING

The following shall be observed when performing gas welding or cutting operations:

074-22.8.1 COMPRESSED GAS CYLINDERS. Transport, handle and store compressed gas cylinders in accordance with OPNAVINST 5100.19 (series) and applicable NSTM chapters. Keep compressed gas cylinders, or gas manifolds used in welding and cutting operations, out of confined spaces. Place gas cylinders or gas manifolds outside the space in open air, away from any fire, explosion or emergency situation. Station an attendant, who shall, in an emergency, immediately turn off the gas supply from the compressed gas cylinders or manifolds.

074-22.8.2 GAS WELDING AND CUTTING EQUIPMENT. Inspect, test, operate and maintain gas welding and cutting equipment such as hoses, connections and torches following procedures outlined in applicable NSTM chapters. Remove torches and hoses from the space at work-crew change and at night. Remove open-ended hoses immediately after disconnecting torches or other devices from the hose.

074-22.8.3 GAS SUPPLIES. Turn off gas supplies at the cylinder or manifold outside the space when equipment is unattended or unused for substantial periods of time, such as at breaks, lunch periods, work-crew changes or overnight.

074-22.9 ELECTRIC ARC PROCESSES

The following shall be observed when performing hot work using electric arc units or machines:

074-22.9.1 ELECTRIC ARC UNITS OR MACHINES. Keep electric arc units or machines outside the confined space. Station an attendant with the unit to disconnect the power source in an emergency.

074-22.9.2 ELECTRIC ARC EQUIPMENT. Inspect, test, operate and maintain electric arc equipment following the provisions of applicable NSTM chapters.

074-22.9.3 ELECTRODE HOLDERS. When electrode holders are left unattended, such as at breaks or during lunch periods, remove the electrodes from their holders. Place holders in a safe location and open the power switch to the equipment. If unattended for longer periods, such as overnight, remove electrode holders, cables and other equipment from the space and disconnect the power supply to the equipment.

074-22.9.4 INERT GAS WELDING PROCESSES. When using inert gases for welding, supply sufficient ventilation to the confined space. Remove inert gases discharged into the space during the operations and provide adequate makeup air. Inspect hoses, connections and fittings for leaks. Position inert compressed gas sources outside the space and turn off at the source when equipment is unattended even for short periods. If unattended for extended periods, such as overnight, remove and disconnect the hoses and torch equipment and turn off the gas supply at the source.

SECTION 23

SPACE CLEANING

074-23.1 INTRODUCTION AND SCOPE

This section sets forth information, guidance and requirements for cold work and cleaning in confined spaces. Cleaning is often required before hot work is approved in tanks and voids. Cleaning may disturb residues and sludges in cargo and sewage tanks releasing toxic or flammable gases or vapors, or both.

074-23.2 COLD WORK DEFINED

Operations which involve only inspections, cleaning or minor repair where no hot work will be conducted. Examples are space inspections, spray painting, chemical cleaning and the use of any strippers, thinners, paints or cleaners that produce vapors.

074-23.3 GAS FREE ENGINEERING REQUIREMENTS

The GFE/GFEA seldom conducts or supervises cold work in cleaning of confined spaces. Such functions are the responsibility of operations or maintenance personnel. However, the GFE/GFEA shall know the various cleaning methods for given circumstances in order to evaluate hazards which may develop during or after cleaning. The GFE/GFEA is responsible for the following aspects of space cleaning operations:

a. Testing, evaluation and certification of the space safe for entry.

b. Specifying requirements for entry and cleaning including ventilation controls, personnel protective equipment and non-sparking tools.

c. Testing and evaluation of the space during cleaning as deemed necessary.

d. Collaboration, when necessary, with cleaning personnel to determine the safest and most effective cleaning method.

074-23.4 GENERAL SAFETY PRECAUTIONS

Observe the following safety and health practices for confined space cleaning:

a. Personnel entering spaces to conduct gas free testing or cleaning operations shall wear protective clothing and equipment adequate for the exposure.

b. Personnel exposed to contaminants during cleaning shall follow good hygiene practice, including wearing clean clothing each day and showering after such work. Personnel exposed to unknown contaminants will contact the medical department for decontamination procedures.

c. Personnel protective clothing and equipment shall be cleaned and maintained in good operating condition.

d. Sludge disturbed after initial tests may release toxic or flammable vapors. Contact with the sludge may also expose personnel to toxic contaminants. Protect personnel who enter such spaces where sludge may contain trapped toxic or flammable materials.

e. Precautions for other hazards such as slipping, tripping or falling, electrical hazards or low overheads or ladders shall be consistent with OPNAVINST 5100.19 (series) and good safety practices, with personnel protective clothing and equipment specified by the GFE/GFEA.

074-23.5 CLEANING METHODS

Many effective methods and techniques may be used to clean a confined space. No single method will suffice for all possible conditions. The method of cleaning is dependent upon the nature of the space and the material in the space. The following technical manuals provide guidance for cleaning operations.

a. Fuel Tanks (Shipboard). NAVSEA MIL-HDBK-291(SH), **Military Handbook, Cargo Tank Cleaning**.

b. CHT tanks, **NSTM Chapter 593, Pollution Control**.

c. The appropriate NSTM chapter (refer to **NSTM Chapter 001, General,** for chapter list or technical publication) for the system or equipment involved (i.e., boilers, condensers or fuel tanks).

074-23.6 STEAM CLEANING

Steam cleaning is the most effective method for cleaning tanks used for low flashpoint hydrocarbon fuels (such as gasoline) and solvents. Steam cleaning removes materials which have permeated seams, scales, blisters or concrete. Observe the following precautions when steam cleaning:

a. Temperatures of tank walls during steam cleaning must not be allowed to exceed 110°C (230°F). Excessive temperatures may cause buckling of walls, warping or cracking of structures, and may also dangerously overheat flammable or combustible materials within boundary spaces.

b. In cases where steam cleaning may damage tanks, use other cleaning methods. (Other methods may be less effective in cleaning tank lines or coatings which contain solvents or fuels, such as gasoline, and may leave residual contamination).

c. Hatches and vent covers in the space should be opened to allow adequate venting during steam cleaning and to prevent excessive pressure build-up.

d. Steam jets may produce static build-up and discharge. Keep steam jets out of spaces which contain flammable vapor concentrations above ten percent of the lower explosive limit (LEL).

SECTION 24

INERTING, PRESSING-UP AND STEAM BLANKETING

074-24.1 INTRODUCTION

Section 24 sets forth the requirements for inerting, pressing-up and steam blanketing. These techniques to achieve safety within a space for the purpose of performing hot work on exterior boundaries are less desirable than cleaning and gas freeing the space as described in Section 19, Section 21 and Section 23.

074-24.2 RESTRICTIONS

Inerting, pressing-up and steam blanketing are permissible only under emergency conditions or when normal cleaning and gas freeing of the confined space are impossible and only under the direction of the GFE/GFEA.

Hot work may be permitted on the exterior boundary of a space which has been inerted, pressed-up or steam blanketed as specified herein and only under the following conditions:

a. The CO shall determine whether the material to be hot worked can withstand the process without structural failure. Deteriorated structures may be so thin or damaged that they will split or burn through.

b. Inerting, pressing-up and steam blanketing are prohibited on spaces containing highly volatile materials such as gasoline, JP-4 fuel or similar materials with flashpoints of 37.8°C (100°F) or less.

c. The space shall be able to be totally isolated from other tanks or spaces, including all interconnecting pipelines and common vents.

d. The working area outside the space shall be certified and maintained Safe for Personnel/Safe for Hot Work.

e. The displaced vapor/air mixture and inerting medium (gas, liquid, steam/vapor mixtures) can be disposed of safely.

f. Before spaces such as fuel tanks are inerted or pressed-up, the tank shall be leak tested using established air test schedules or equivalent.

074-24.3 GAS INERTING

Inerting involves replacing oxygen/vapor mixture in the space with inert or non-flammable gas so that the resulting atmosphere will not support combustion. For additional information on installed systems, refer to **NSTM Chapter 542, Gasoline and JP-5 Fuel Systems**.

074-24.3.1 INERTING PRECAUTIONS. The oxygen level which supports combustion varies with the contaminant present and the inerting medium. For a space to be fully inerted, the oxygen level shall be reduced to less than one percent. Due to its expansion ratio and freedom from static discharges, dry nitrogen gas is the preferred medium for inerting.

WARNING

Nitrogen heated to 482.2°C (900°F) becomes nitrogen dioxide, which is toxic.

a. Liquid levels in the space shall permit free distribution of the inerting gas. Adjust liquid level to allow a minimum space of 12 inches between the top of the liquid and the lowest edges of any structural members or baffles.

b. Pockets of vapor may collect between structural members or on the high side of slanting tanks which will restrict even distribution of the inerting gas. Eliminate all such vapor and air pockets by drilling a vent hole in the structure at each location of trapped vapor and air. Use air-powered tools and a coolant such as water for such drilling. After venting the pocket and testing the exhaust from the hole or the desired inertness, plug the hole.

CAUTION

Particles of freezing compressed carbon dioxide (CO_2) generate static electricity which can discharge and ignite a flammable atmosphere. Therefore, the use of CO_2 portable fire extinguishers for the purpose of inerting tanks or containers that contain or have contained hydrocarbon products is prohibited.

c. When compressed CO_2 is used as an inerting medium, a too-rapid discharge rate can cause the gas to freeze, creating excessive turbulence and uneven distribution. When using CO_2 as an inerting medium, the following shall apply:

   1. Use bulk, non-compressed, low-pressure CO_2 whenever possible.
   2. Introduce compressed, high-pressure CO_2 only through an expansion manifold or receiver.
   3. Control flow rate to prevent rapid, freezing discharge.

074-24.3.2 EXHAUST VENTILATION. Vent all gases from a space to the outside atmosphere both during and after the inerting process. When tank vents do not discharge to the outside, attach fittings and vent hose to provide such ventings. When atmospheric conditions slow the dispersion of exhausted gases, use an explosion-proof blower. Ensure that vented gases do not drift into other spaces, compartments or low areas.

074-24.3.3 GAS INERTING GENERAL PROCEDURES. Observe the following general procedures for inerting a space with gas:

a. Satisfy all conditions stated in paragraph 074-24.2.

b. Adjust tank liquid, if necessary, to provide at least 12 inches of free space between the liquid surface and the lowest edge of any structural members or baffles.

c. Isolate the tank, including all interconnecting vents, pipes and similar items.

d. Calculate the volume of free air or vapor space above the liquid. From this volume, determine the amount of inerting gas required for the initial injection. To allow uneven distribution and diffusion, the volume of the

initial gas injection should equal the volume of the free tank space. Compressed gases may be converted from pounds (lbs) to cubic feet (cf) for purposes of this calculation, as follows:

1 lb carbon dioxide = 8.75 cf and

1 lb nitrogen = 13.75 cf. Where non-compressed gas is used, a flow meter may be used to determine the quantity of gas injected into the space.

e. Install the necessary fittings for injection of the inerting gas and venting of vapor/air mixtures. Gases heavier than air, such as CO_2, need an inerting gas inlet at the bottom of the space to be inerted (within six inches above the liquid surface), and a vent at the top of the space. Gases lighter than air, such as nitrogen, need the inlet placed higher than the outlet. Inlets and outlets should be spaced as far apart as possible.

f. Inject the inerting gas. Test for oxygen content at the vent. Continue injecting until there is a consistent oxygen reading of less than one percent at the vent. Close the vent and allow 30 minutes for diffusion of the inerting gas. After 30 minutes, retest the oxygen content at the vent. If the oxygen content is more than one percent, close the vent and inject inerting gas until a detectable pressure is present within the space. Never exceed the pressure rating of the space. Pressure for inerting should not exceed **one pound per square inch gauge (lb/in^2 g)**.

g. Treat vapor pockets as indicated in paragraph 074-24.3.1.b.

h. Monitor pressure on the space continuously during hot work. If the pressure rises, stop work. Find and correct the cause of the pressure rise before resuming hot work.

i. If a positive pressure cannot be applied and maintained because of the nature of the space, a continuous flow of inerting gas should be injected through the space. Test continuously at the vent.

j. Upon completion of hot work, allow sufficient time for all affected surfaces to cool to normal temperatures. The inerting medium should be vented to the outside atmosphere.

074-24.4 PRESSING-UP RESTRICTIONS

Resort to pressing-up only in emergencies when spaces cannot be cleaned and gas freed normally, as described in Section 23 or cannot be gas inerted as described in paragraph 074-24.3.3.

Pressing-up is a means of displacing flammable vapor/air mixtures from a space by completely filling the space with liquid. In addition to the general restrictions of paragraph 074-24.2, observe the following specific restrictions for pressing-up operations:

a. Pump as much flammable or combustible liquid as possible from the tank or space to be pressed-up.

b. Press-up the tank or space with water only.

c. Restrict hot work to an area at least 12 inches below the water level. Residual fuels in the tank will, in most cases, rise to the top of the water used for pressing-up. Prevent hot work on the tank top or on areas above the water level where residual fuels may be present. For hot work closer to the tank top, pump residual fuel out and continue pressing-up with water until only water remains.

d. Drill vent holes for any suspected vapor or air pockets as described in paragraph 074-24.3.1. After drilling, continue pressing-up until the pocket is filled with water.

e. Ensure that the strength of the tank walls is not exceeded.

074-24.5 STEAM BLANKETING

Steam blanketing is a method of making the outer boundaries of a space Safe For Hot Work by using steam to displace and carry off flammable vapor/air mixtures within the space. Steam blanketing is not practical as an alternative either to cleaning and gas freeing the space as required in Section 23 or to gas inerting as described in paragraph 074-24.3. Steam blanketing can be effectively used for closed items (such as rudders or skegs) which may contain flammable rust inhibitors or coatings.

074-24.6 STEAM BLANKETING REQUIREMENTS

The following requirements apply to steam blanketing operations:

a. Satisfy the conditions specified in paragraph 074-24.2.

b. Examine surrounding compartments and spaces to determine that a rise in temperature from the steaming operations will not create a hazard or cause damage to the compartment or its contents.

c. Adjust liquid level, if any, to provide at least 12 inches of free space between the liquid surface and the lowest edge of any beam or structural member, then close the space.

d. Place the steam inlet at the top of the vapor space, and the outlet within six inches of the liquid level or bottom of the vapor space, since steam is lighter than air.

e. Install a steam pressure gauge near the steam inlet. Monitor pressure within the space continuously throughout the steam blanketing process. Should pressure within the space rise above **one pound per square inch gauge (lb/in^2 g)**, secure steam inlet valve. Locate and correct the cause for the pressure rise before steaming is continued.

f. Introduce the steam well in advance of hot work operations (approximately 3 hours) and continue throughout the entire operations.

Test at the outlet to ensure that no flammable vapor/air mixtures are present before commencing hot work.

g. Steam must be visible during operations. If the steam becomes too dry to be visible, inject water into the steam inlet line until the steam is again visible. Stop hot work until the cause for the lack of visible vapor in the steam outlet has been determined and corrected.

h. Drill vent holes as described in paragraph 074-24.3.1.b to remove any suspected flammable vapor/air pockets.

i. Monitor temperatures of space walls and boundaries; maintain tank wall or boundary space temperatures at no more than 110°C (230°F).

SECTION 25

EMERGENCY RESCUE PROCEDURES

074-25.1 INTRODUCTION

The following procedures apply to emergency rescue of personnel from confined spaces aboard ship. These procedures can also be applied to rescue during a planned shipboard gas free engineering evolution.

074-25.2 RESPONSIBILITIES OF RESCUE PERSONNEL

A description of each person's responsibilities is listed below:

a. GFE (or GFEA in the absence of the GFE) - directs the rescue operation at the access to the confined space in accordance with the rescue plan. The GFE coordinates the entire operation and is the focal point of communications, instructions and information. The GFE responds to requests for equipment, relays medical information, etc.

b. Primary Rescue Team - consists of two rescue personnel: the investigator and one rescuer. This team is the first rescue team to enter the confined space and is responsible for initial contact, assessment and safe removal of the victim(s) from the space. The investigator directs the rescue within the space and communicates requests for assistance to the GFE/GFEA.

c. Secondary Rescuer(s) - Secondary rescue personnel shall be stationed near the access to the confined space wearing the respiratory protection specified in paragraph 074-25.3. Secondary rescue personnel shall be ready to enter the space as directed by the GFE/GFEA in the event that the primary rescue team requires assistance. Secondary rescuers shall be capable of assuming the responsibilities of the primary rescue team should the need arise. The number of required secondary rescuers shall be determined by the GFE/GFEA based on the investigator's assessment of the situation and the most appropriate means for removing the victim(s) from the space. If secondary rescue personnel must enter the confined space, there must be at least one additional standby rescuer stationed near the access to the space wearing (in standby) the respiratory protection specified for confined spaces.

d. Attendants - personnel stationed near the access to the space, who perform the following tasks:
   1. Assist the personnel in donning safety harnesses, lines and respiratory equipment.
   2. Tend safety lines and air hoses from Escape SCBA, if used.
   3. Monitor supply air to personnel inside space, and replace air bottles as required to maintain a continuous supply of air, if SARs/SCBA System is used.
   4. Establish and maintain communications with personnel as specified in the established rescue plan.
   5. In the event of a casualty, alert appropriate personnel as specified in the established rescue plan.
   6. Erect and man the hoisting equipment if it is necessary to vertically retrieve personnel from a confined space. Space permitting there shall be one attendant for each rescue person who enters the space. This attendant is responsible for tending the rescue person's air hose, safety line and communication lines, if used. The number of attendants required and the specific responsibilities of each attendant shall be determined by the GFE/GFEA, based on the requirements of the situation (such as the number of victims to be rescued and space constraints).

e. Master at Arms - assists the GFE/GFEA in management of personnel and crowd control in the vicinity of the confined space.

f. MDR - advises the GFE/GFEA regarding medical aid in the event there is a victim(s) in the space and con-

tinues aid once the victim(s) is removed from the space. The MDR shall also monitor the victim's use ofother emergency breathing equipment and advise the GFE/GFEA when replacement is required.

g. Electrician - provides assistance as directed by the GFE/GFEA.

h. DC central phone talker - maintains communications with the scene and the bridge or quarterdeck. Additionally, this person directs personnel or equipment to the scene as requested by the GFE/GFEA.

i. OOD - maintains communications with DC central on the current status of the operation and provides additional assistance as directed by the GFE/GFEA.

074-25.3 EQUIPMENT

The following equipment shall be used to support personnel rescue from the confined space:

Equipment carried into space must be tethered to personnel to prevent loss of or damage to the equipment.

a. Respiratory equipment worn by all personnel who enter the confined space. If SARs/SCBA SAR/SCBA System is used, two Primary Air Supply Packs (PASPs), Reserve Air Supply Packs (RASPs), and at least four airline Escape SCBAs with hose sections for each shall be available at the scene.

b. Safety harnesses with attached safety lines.

Because of time required to don safety harness, it should be among first equipment to arrive at the scene.

The safety line shall be 1/2 inch diameter (or larger) nylon line (length determined by size of space) and attached to the harness with a snap hook.

c. Intrinsically safe communication devices (such as radios or sound powered phones) to be worn by personnel entering the confined space.

d. Medical equipment including stretcher(s), and the MDR's first aid kit.

e. Hoisting equipment, such as the Rescue Davit System (RDS) used on large decks, for removing personnel vertically from confined spaces more than five feet deep. See Appendix M for description of the RDS.

f. Intrinsically safe inspection and support equipment, such as a combustible gas indicator, oxygen monitor and portable explosion-proof lighting (flash lights, chemical lights).

g. Personnel protective clothing, such as gloves, boots, helmets and coveralls, as determined by the GFE/GFEA.

074-25.4 ENTRY PROCEDURES

When personnel must enter a confined space for emergency operations, including emergency repairs, utilize the IDLH Space Emergency Entry Checklist found in Appendix C and the following requirements apply:

a. Prior to confined space entry, the GFE/GFEA shall develop an entry plan, to the extent practical. In emergency situations, a written plan may not be possible; however, the following items shall be considered prior to entry:
   1. Determine which type of respirators will be worn by personnel entering the space. If SAR/SCBA is used, the number of RASPs to support the entry shall be determined.
   2. Identify obstacles in the space which could impede entry, operations or which are safety hazards, such as the deck contour, deck beams, moisture or fluids on the deck, height to the overhead and pipe runs in the space.
   3. Determine the equipment required for the emergency operations and the safety equipment required to support personnel in the space. This equipment, which must be intrinsically safe, may include a combustible gas indicator, oxygen monitor and portable explosion-proof lighting. Additionally, the order in which this equipment is to be brought into the space should be determined.
   4. Establish the means for communicating between personnel in the space and attendants. For larger spaces or ones with obstacles which can impede testing or are safety hazards, radios, sound powered phones or a messenger should be used to pass information and testing progress between test personnel in the space and attendant personnel outside space.
   5. Determine the number of personnel needed in the space and the amount of time personnel must be inside the space to conduct the emergency operations.
   6. Establish a plan to rescue personnel from the space should they become incapacitated during the testing. Refer to paragraph 074-25.5 for guidance in developing a rescue plan.
   7. Inform the MDR and request that the MDR be ready to respond immediately in case of personnel emergency.
   8. Inform the following personnel prior to and upon completion of the confined space entry:
      (a). When underway: the DCA, the EOOW, cognizant department head and OOD.
      (b). When in port: the CDO, duty engineer, cognizant department head, the OOD, FM and DC central.

b. The GFE/GFEA shall brief the personnel who conduct and support the space entry. The briefing will detail the entry and rescue plans, including obstacles impeding operations or rescue, safety precautions and personnel assignments.

c. Attendant personnel shall be continuously posted immediately outside the access to the space while personnel are within the space.

d. During the period that personnel are inside the confined space, the GFE/GFEA shall ensure the secondary rescue team (an investigator and one rescuer) is on standby near the space access. When these rescue personnel must enter the confined space, there must be at least one additional rescuer on standby near the access to the confined space.

Rescue personnel shall maintain the respiratory protection equipment on standby and not enter the space until directed by the GFE/GFEA. Refer to paragraph 074-25.5 for rescue procedures.

074-25.5 RESCUE PROCEDURES

The procedures for entering the space to rescue victim(s) follow:

Rescue personnel shall enter the confined space only when directed by the GFE/GFEA.

a. The primary rescue team shall don safety harnesses and safety lines with the assistance of the attendant(s).

b. The primary rescue team shall don the respiratory equipment in standby mode with the assistance of attendants(s).

c. The primary rescue team shall check operation of all communications equipment.

d. The GFE/GFEA shall assess the situation and determine if a potentially explosive atmosphere may be present inside the confined space.

To ensure the safety of rescue personnel, a rescue team shall always consist of at least two rescuers inside the space.

If any problems arise with the respiratory equipment, rescue personnel being supplied breathing air shall exit the space immediately. If equipped with an Escape SCBA, activate the backup air supply (if necessary), activate the backup air supply, disconnect the supply air hose only if it is impeding escape from the space, and exit the space immediately. Rescue personnel may re-enter the space after the problem has been resolved, breathing air is restored and the backup air supply is fully charged.

e. When directed by the GFE/GFEA, the primary rescue team shall activate their air supply and enter the space, equipped with explosion-proof lighting, communications for each victim. Before entering the space, each person shall ensure that air is being supplied to the facepiece.

f. When inside the space, the investigator shall locate the victim(s), assess the situation and identify any potential hazards to the rescue operation. During the rescue operation, the investigator shall update the GFE/GFEA regarding the status of the rescue and request any required assistance.

g. Secondary rescuers, equipped with respiratory equipment, harnesses and safety lines shall enter the space when directed by the GFE/GFEA. If these rescue personnel must enter the confined space, there must be at least one additional rescuer stationed near the access to the confined space wearing (in standby) the respiratory protection specified for spaces.

h. The GFE/GFEA shall direct, as appropriate:
   1 The electrician to check, deenergize or energize ship's circuits to assist with rescue.
   2 Attendant personnel to erect and man hoisting equipment at the access in order to remove victim(s) from the space.

i. The GFE/GFEA shall request DC Central to provide additional equipment and personnel as required to assist with the rescue.

j. The GFE/GFEA shall report the status of rescue efforts to DC Central. DC Central shall relay these reports to the bridge or the quarterdeck, as appropriate.

074-25.6 ATTENDING TO VICTIMS

The procedure for rescue of personnel from the space shall be as follows:

a. The primary rescue team shall locate the victim(s), and determine if the victim(s) is alert.

b. Once it is established that the victim is being provided an adequate supply of air for breathing, the investigator may check the victim for broken bones and lacerations. The purpose of this check is to determine whether first aid must be administered while the victim is in the space.

c. If it cannot be established that the victim is being provided an adequate supply of air for breathing, the priority of the investigator and rescuer(s) shall be to provide another source of breathing air for the victim. EEBDs can be used only if victim is conscious and use of EEBD is not prohibited in space. Without the use of the EEBD, three options are available:
   1. Removing the victim(s) from the confined space.

If SCBA is used on the victim, the SCBA cylinder and harness assembly shall not be placed on top of the victim. If the victim is dragged or carried, the cylinder/harness shall be carried by one of the rescuers. If the victim is transported on a stretcher, the cylinder/harness shall be secured to the stretcher at knee level after the victim has been secured to the stretcher.

If it is requested that a SCBA air supply be provided for the victim(s), an attendant shall activate the air supply to the facepiece and check that adequate breathing air can be provided to the facepiece before it is brought into the space.

   2. Providing the victim with a positive pressure SCBA air supply, or
   3. Providing the victim with an oxygen bottle breathing mask from the medical representative (non explosive atmosphere only)..

d. The investigator shall make the determination to remove the victim(s) from the space or provide the victim with breathing air based on the following considerations:
   1. Estimated time victim has been in space without air.

2. The nature and severity of the victim's injuries and the risk of jeopardizing the life of the victim during transport.
3. The time required to transport the victim to a fresh air environment.

If a harness is used to hoist the victim from the space, the hoist line shall be connected to a Y-bridle attached to the harness shoulder straps.

Rescuers should not attempt to remove victim(s) from the space by pulling victim(s)' safety line(s). Safety lines can be used to assist in vertical lifts of the victim when it has been established that such lifts will not injure the victim.

e. The victim should be transported out of the space by the quickest means which does not aggravate injuries and permits continued breathing air supply. Alternatives which should be considered are dragging the victim across the deck, use of a stretcher or the firefighter's carry. If it is necessary to hoist the victim out of the space, either a stretcher or a safety harness can be used. The selection should be based on the time required, the victim's injuries and the supply air to the victim from the respiratory equipment being used.

f. When hoisting a victim from the space with a stretcher or harness, the rescuers in the space shall maintain communications with the attendant hoist operators so they can direct the hoisting operation.

074-25.7 RESCUE PERSONNEL TRAINING

The GFE/GFEA is responsible for supervising, planning and training personnel participating in confined space rescue. This training shall be in accordance with the procedures provided in this section. Training shall include the following:

a. Designation of specific responsibilities of each person.

b. Proper use and maintenance of equipment.

c. Training/drills performed at least semi-annually to maintain proficiency of personnel in the performance of their duties.

SECTION 26

POST-FIRE ATMOSPHERIC TESTING

074-26.1 POST-FIRE ATMOSPHERIC TESTING ON SURFACE SHIPS

Post-fire atmospheric testing is performed by the GFE/GFEA and designated assistants. Tests may be conducted by GFEPOs with results evaluated by the GFE/GFEA. If GFEP are assigned other duties in the at-sea and inport emergency organization, those duties should not interfere with their ability to perform testing during the casualty. Testing should commence as soon as possible in surrounding areas in order to move smoke or toxic gas boundaries inward as soon as possible. All spaces should be desmoked before atmospheric testing is started because oxygen analyzers do not operate reliably if the sensor is exposed to excessive moisture or is in contact with post-fire atmospheric particulates. Also, combustible gas analyzers will not operate reliably in a Halon atmosphere or oxygen deficient atmosphere. One series of atmospheric tests in sequence for oxygen, combustible gases and toxic gases is required. The level of oxygen shall be between 19.5 percent and 22 percent, combustible gases shall be less than 10 percent of the LEL and all toxic gases below their PELs before the space is certified safe for personnel. Ventilating and retesting is only required if initial test results are unsatisfactory. This guidance is applicable for all classes of fire. Toxic testing for Class A and Class C fires is the same except that hydrocarbon tests are not required. Hydrocarbons are present with flammable liquids. Hydrogen chloride (HCL) is a by-product of burned polyvinyl chloride cable jacketing. Hydrogen cyanide (HCN) is present when vinyl nitrile rubber water piping insulation is burned. Hydrogen fluoride results from the decomposition of Halon 1301. If the space may have been contaminated by chemical, biological or radiological (CBR) agents, testing for CBR contamination should be conducted in accordance with **NSTM Chapter 470,** and NWP 3-20.45.

074-26.2 POST-FIRE ATMOSPHERIC TESTING ON SUBMARINES

The purpose of post-fire atmospheric testing is to certify the atmosphere as safe, which includes safe for breathing without respiratory protection. After the fire is extinguished, the area is first desmoked. Then a series of tests are conducted in the compartment in the following order: oxygen level, flammable gases, toxic gases. As previously noted in paragraph 074-26.1, if all three factors are achieved, the space is certified for entry. All spaces should be desmoked before atmospheric testing is started because oxygen analyzers do not operate reliably if the sensor is exposed to excessive moisture or is in contact with post-fire atmospheric particulates. Also, combustible gas analyzers will not operate reliably in oxygen deficient atmospheres. If a particular location fails a test, only that location must be retested for the failed test. Additional ventilation and retesting is required only if initial test results are unsatisfactory. This guidance is applicable to all classes of fire. For a satisfactory test series:

a. Oxygen concentrations shall be as specified in **NAVSEA S9510-AB-ATM-010(U), Nuclear Powered Submarine Atmosphere Control Manual**.

b. Combustible gas concentrations shall be less than ten percent of the LEL.

c. Toxic gas concentrations shall be acceptable as specified in **NAVSEA S9510-AB-ATM-010(U), Nuclear Powered Submarine Atmosphere Control Manual**. For a Class A or C fire, the toxic gas series shall include carbon monoxide (CO) and carbon dioxide (CO^2). The toxic gas series shall include HCL and HCN when materials which produce these gases have been involved in the fire. For a Class B fire, an additional toxic gas test for hydrocarbons is required. HCL is produced when polyvinyl chloride electric cable jacketing is burned. Hydrogen is produced when vinyl nitrile rubber submarine hull insulation or chilled water piping insulation is burned. Test for other toxic gases when their presence is suspected. Toxic gas concentrations on submarines shall be below the exposure limit as specified in NAVSEA S9510-AB-ATM-010(U) (see Table 074-26-1). Use of 90-day exposure limits is recommended.

Table 074-26-1. TOXIC GAS EXPOSURE LIMITS FROM THE SUBMARINE ATMOSPHERE CONTROL MANUAL

Chemical Name	90-Day Limit	24-Hour Limit	1-Hour Limit	Other Limits
Carbon monoxide (CO)	20 ppm	50 ppm	400 ppm	
Carbon dioxide (CO_2)	0.05%	4%	4%	
Hydrocarbons				
(a) Total aromatics (less benzene)	10 mg/m^3			
(b) Total aliphatics (less methane)	60 mg/m^3			
Hydrogen chloride (HCL) i.e., hydrochloric acid	0.5 ppm	20 ppm	20 ppm	
Hydrogen cyanide (HCN) i.e., hydrocyanic acid				4.7 ppm (STEL)
NOTE: The Submarine Atmosphere Control Manual currently lists no exposure limit for HCN; however, there is a short term exposure limit (STEL) of 4.7 ppm for 15 minutes				

If the one-hour (emergency) or 24-hour exposure limit is used to permit removal of emergency air breathing (EAB) masks, duration of crew exposure should not exceed the designated period of time.

When more than one toxic gas is present, the cumulative effects of the gases may be hazardous even though the concentration of each gas is below the exposure limit.

Do not use the submarine central atmospheric monitoring system (CAMS) until it has been determined there are no acid gases, such as HCL, present. Acid gases will damage the CAMS. The CAMS may be used for post-fire atmospheric testing when it is ensured that no acid gases are present.

074-26.3 LOCATIONS FOR ATMOSPHERIC TESTING

Test locations are determined by the GFE/GFEA or other authorized personnel. The following guidance is provided to aid in determining appropriate locations. However, additional test locations may be needed depending on specific conditions. This guidance does not replace the good judgment of knowledgeable test personnel.

074-26.3.1 GENERAL. During a fire, combustible or toxic gases spread with smoke and heat. Fire gases initially rise due to their buoyancy from being hotter than surrounding air. However, as fire gases cool and mix with surrounding air, particularly outside the fire space, they spread through the ship with normal air currents. Generally, atmospheric testing should be conducted in the fire space and at locations high, center and low in the affected water-tight compartment since some gases are lighter or heavier than air and may accumulate high or low. The rate of ventilation air changes will vary for different ship locations. Extra ventilation and testing may be required for locations or spaces which have a low ventilation rate since they can maintain hazardous concentrations of flammable or toxic gases. Residual light smoke is a sign of a poorly ventilated location and indicates the need for additional ventilation and testing.

074-26.3.2 SMALL FIRES. When a small fire (such as a waste can or localized electric fire) is extinguished quickly, there is little fire damage and light smoke which does not spread beyond the fire space. In this case, the spread of toxic gases is probably minimal. Therefore, a single test series at one location in the fire space may be adequate and overboard desmoking may not be necessary. The need for testing will be determined by qualified personnel in charge.

074-26.3.3 GROWING FIRES. In the event of a growing fire where smoke spreads beyond the original fire space, a single test site is not sufficient even when the ventilation system remains undamaged. After desmoking, atmospheric tests should be conducted in a least one site in the fire space (i.e., fire area) and at sites high, center and low in the water-tight compartment. Other atmospheric test series should be conducted on each level adjacent to the fire area. (This would result in four test sites in a three-level compartment). Additional sites should be tested where poor ventilation and gas accumulation is suspected.

074-26.3.4 LARGE FIRES. When a large fire damages the ventilation system or extensive partially-burned material remains, (including the results of a Class B fire) extensive post-fire atmospheric testing will probably be required. A damaged ventilation system will result in poorer air replacement and a greater likelihood of local pockets of smoke and gases. Large surfaces of partially-burned material or unburned flammable liquids will result in continued formation of hazardous gases and vapors after the fire. Locations for atmospheric testing should include the four corners and center of each level. In areas where low ventilation and gas accumulation are suspected, additional ventilation and testing should be conducted.

SECTION 27

NAVY GAS FREE INSTRUMENTATION

074-27.1 APPROVED INSTRUMENTS

The GFE/GFEA is responsible for all GFE instrumentation and its usage. The GFE/GFEA shall ensure that all necessary and suitable instruments and equipment are readily available and properly maintained and stowed. There is no current requirement to stow additional instrumentation in each repair station for use by the repair party since such stowage incurs added maintenance and shelf-life-expiration replacement costs. Only gas free equipment that complies with OSHA shall be used to provide GFE services. (Approval seals are placed on all equipment that complies with OSHA standards.) Additional information on approval seals and a list of gas free equipment available in the stock system is contained in Appendix K. At a minimum, instruments for testing shall include the following:

a. Oxygen content

b. Combustible atmospheres

c. Toxic atmospheres - capability to test for expected and potential toxicants

d. Maintenance of prescribed air flow.

Portable gas free detection instruments and their stock numbers listed in Appendix K; chemical detection tubes are listed in Appendix L.

NOTE

Ships and activities having unlisted instruments which perform the required testing functions satisfactorily should not replace such instruments solely on the basis of their absence from Appendix K and Appendix L.

074-27.2 INSTRUMENT LIMITATIONS

Many instruments presently available for gas free testing have limitations which may affect the accuracy of the test results. Examples of such limitations include:

a. Combustible gas indicators that function by a circuit imbalance (created by combustion of the sample inside the instrument) will not function correctly in oxygen deficient or -enriched atmospheres.

b. Each instrument is designed and built to function correctly or safely in certain classes of hazardous atmospheres. A combustible gas indicator designed for use only in a Class I, Division 1, Group D atmosphere (see Appendix K, for definitions) may be unsafe to use in Group A or B atmospheres such as acetylene or hydrogen.

c. Certain contaminants present in the atmosphere may interfere with the function of the instrument and directly affect its accuracy. Therefore, readings must be adjusted to correct for the presence of such materials. Other materials may poison the sensors or filaments of the instrument and produce false readings or instrument failure.

d. Changes of altitude or atmospheric pressure can affect the performance of certain instruments, requiring that the instruments be calibrated for existing conditions.

e. EMI resulting from the use of portable radios in close proximity to explosimeters, oxygen indicators and four gas analyzers can cause erratic or lower than normal readings of the instruments.

f. Relative humidity can affect the performance and accuracy of instruments. Humidity greater than 95 percent may result in significantly degraded performance.

Gas free engineering personnel shall be thoroughly trained in the use of all instruments applicable to their operations and shall consult and observe manufacturers' instructions and directions regarding capabilities and limitations of the instruments. Instruments shall be used only for their designed purpose and within the limitations specified by the manufacturer.

074-27.3 CALIBRATION AND MAINTENANCE

In order to avoid possible serious injury to personnel, it is imperative to follow manufacturers' procedures and requirements when operating portable gas free instruments.

Instruments shall be calibrated and maintained in good operating condition, to include:

a. Each portable instrument is calibrated using the manufacturer's factory-selected calibration gas (such as methane) to obtain that instrument's reading. This reading shall be compared with the instrument's appropriate conversion charts/curves to obtain actual concentration for a specific contaminant gas.

b. A sufficient supply of spare parts (i.e., flashback arresters, filters and filaments) will be kept on hand to avoid excessive downtime for repairs. Perishable parts (i.e., batteries, sensors and operational check kits) shall be stocked, replenished and issued consistent with shelf-life limitations.

c. Instruments shall be calibrated in accordance with manufacturer's instructions and maintenance requirement cards (MRCs) immediately before each use. If instruments fail to respond, or respond incorrectly to known calibration conditions, they shall be removed from service, tagged as defective and either referred to an appropriate repair facility or returned to the manufacturer for repair.

The Navy's METCAL program no longer requires periodic testing and calibration of portable gas free equipment.

074-27.4 FOUR GAS ANALYZER

The current Navy standard shipboard four gas analyzer is the BIOSYSTEMS PhD Ultra, P/N 35-30102NU. It is available, with other components described below, as a kit under NSN 4240-LL-TRP-8965. The calibration kit is BIOSYSTEMS P/N 54-05-K0502, NSN 4240-LL-TRP-5533. Other analyzers meeting the requirements of Appendix K may also be used. The portable, battery-powered four gas analyzer is used to monitor and to alarm on preset concentrations of combustible gases, oxygen, carbon monoxide and hydrogen sulfide. The operator can mount the instrument on the chest or the waist. In either location, the operator can simultaneously see all four gas concentrations and any visual alarms. The primary alarm is an audible alarm, the visual alarm is a back-up

alarm for high noise environments. The four gas analyzer is water, shock and EMI resistant. The four gas analyzer is composed of two kits, the analyzer kit and the calibration check kit, which contain all components necessary for shipboard use of this equipment. The manufacturer's reference manual includes all information necessary for use. Appendix K provides Navy-specific operating requirements and safety precautions repeated here for emphasis. Basic operating procedures are provided as an overview.

074-27.5 EXCLUSIONS

The four gas analyzer is not currently authorized for use in measuring hydrogen to support nuclear propulsion plant casualty procedures or to support monitoring of submarine propulsion battery hydrogen release. In addition the four gas analyzer shall not be used to measure the toxicity of hydrocarbon gas because the range and scale (percentage of LEL as opposed to ppm or mg/cubic meter) are not appropriate for this measurement.

074-27.6 SAFETY PRECAUTIONS

The four gas analyzer is designed to detect gases which could cause death by suffocation or toxicity or which could cause explosions. Due to hazards involved, the four gas analyzer shall be operated and serviced only by qualified personnel. Personnel operating the four gas analyzer shall read and understand the manufacturer's reference manual prior to operating or servicing. The following safety precautions are repeated for review and compliance:

a. Any rapid up-scale reading followed by a declining or erratic reading may indicate a gas concentration beyond upper scale limit which may be hazardous.

b. Accuracy of the analyzer unit should be checked with known concentration calibration gas before any daily period of use.

c. The four gas analyzer has been designed for the detection of oxygen deficiencies, flammable gas and toxic vapor levels. An alarm condition indicating the presence of one or more of these potentially life threatening hazards should be taken very seriously. In the event of an alarm condition, it is important to follow established procedures. The safest course of action is to immediately leave the affected area and return only after further testing together with appropriate safety procedures, determines that the area is once again safe for entry.

d. Do not store or leave the four gas analyzer with the battery pack removed.

e. The four gas analyzer is designed to turn itself on whenever a battery pack is removed or replaced. This is to ensure that in the event of an interruption of power the analyzer unit is not accidentally turned off. Any time a battery pack is momentarily removed or replaced with another, it will be necessary to manually turn the analyzer unit off if it is not going to be put to immediate use.

f. An optional alkaline battery pack is available for the BIOSYSTEMS PhD Ultra multigas detector. Do not use an alkaline battery pack other than BIOSYSTEMS P/N 35-921 with the BIOSYSTEMS PhD Ultra. Use of other battery packs will compromise the analyzer unit's intrinsic safety and could ignite an explosive atmosphere.

g. Only fully assembled alkaline battery packs may be removed or replaced while the analyzer unit is being used in a hazardous location. Alkaline battery packs shall not be opened and alkaline batteries shall not be replaced while the battery pack is located in a hazardous atmosphere.

h. When the four gas analyzer displays the message, ″Needs Cal″, it should not be put back into service or used until the accuracy of any affected sensor has been verified by exposure to the appropriate known concentration gas test.

i. Do not locate the four gas analyzer in a hazardous location while being recharged. Likewise, if the NICAD battery pack is being recharged separately from the instrument, the four gas analyzer charger must not be located in a hazardous area. (The four gas analyzer is classified by Underwriters Laboratories and the Canadian Standards Association as intrinsically safe for use in Class I, Division I, Groups A, B, C and D hazardous locations. This classification is voided if the four gas analyzer is connected to the battery charger in a hazardous area.)

j. Hand-aspirated remote sampling provides continuous gas reading only so long as the bulb is being squeezed.

k. Never operate the sample draw pump unless the hose and probe assembly are attached. The sample probe handle contains replaceable filters designed to block moisture and remove particulate contaminants. If the pump is operated without the probe assembly in place, contaminants may cause damage to the pump.

l. Do not insert the sample draw tube and probe into a fluid.

m. Check the accuracy of the four gas analyzer immediately following any known exposure to contaminants by testing with known concentration test gas. This accuracy check should be performed prior to further use. (See Manufacturer's Reference Manual, paragraph 3.1.1.1, paragraph 3.1.1.2 and paragraph 3.1.1.3.).

n. After a combustible sensor alarm condition has occurred, locate the analyzer in a fresh air environment prior to turning the analyzer on. Auto zero adjustment may be made only when the analyzer unit is located in air that is known to be fresh. Accuracy of the combustible gas sensor should be verified by exposure to known concentration test gas before further use.

074-27.7 FOUR GAS ANALYZER KIT COMPONENTS

The following components are included as part of the four gas analyzer kit:

074-27.7.1 ANALYZER UNIT (INSTRUMENT). The analyzer unit is required to be portable, lightweight and sufficiently rugged for shipboard use. Battery powered with NICAD battery pack, it will operate for eight hours after an eight-hour charge. It will operate for up to 12 hours if fully charged. Key features include an alarm light, battery pack, sensor compartment, four sensors, sensor cover and a backlit liquid crystal diode (LCD) display which can be read in red light conditions. In addition, the unit includes single button operation, a belt clip and a recessed battery charger connector. The four gas analyzer unit may be used in either the local mode, sampling in the diffusion mode or in the remote mode. The four gas analyzer unit stores up to 60 hours of monitoring data. Ships are not provided with the interface or software for downloading this data. The data may be downloaded if it is necessary to review conditions associated with casualties.

074-27.7.2 REMOTE SAMPLING EQUIPMENT. The four gas analyzer kit includes both a hand pump (aspirator bulb) and a battery-powered motor driven pump. The motor-driven pump is powered from the analyzer unit's battery. Both pumps can be used with the remote sampling tube and sampling probe provided with the kit. There are two lengths of remote sampling tubing approximately 19 and 33 feet, and fittings to connect the hoses together. This is long enough to reach the bottom of deep tanks and access trunks. The sampling probe mounts a filter and a water barrier to protect the instrument from damage to the pump and sensors, in the event water or particles are sucked into the remote sampling tube. Both pumps include an adaptor which slides onto the analyzer unit over the sensor cover.

074-27.7.3 BATTERY CHARGER. The four gas analyzer unit slips into the included NICAD battery charger to recharge the batteries. The battery pack can also be removed from the unit and inserted into the charger for independent charging. The charger is powered from a 110 VAC adaptor.

074-27.7.4 SPECIAL TOOLS. The only special tool required is a screwdriver for use in removing the sensor cover.

074-27.7.5 PROTECTIVE SHEATH AND MOUNTS. The four gas analyzer unit fits into a protective leather sheath. The sheath includes rings to attach the chest/shoulder mount strap. The belt mount clip is included on the unit itself. When wearing on the belt, it is recommended that the user don the device using a utility belt. It is also recommended that, when not worn on the belt, the unit be held with the chest/shoulder strap around the neck, to prevent dropping the unit.

074-27.7.6 MANUFACTURER'S COMMERCIAL TECHNICAL MANUAL (REFERENCE MANUAL). Each four gas analyzer kit includes the manufacturer's reference manual.

074-27.7.7 FOUR GAS ANALYZER KIT CARRYING CASE. The case holds all components of the four gas analyzer kit. Foam cushioning is included to protect the components. The case has a rigid shell and is water resistant.

074-27.8 CALIBRATION KIT COMPONENTS

The four gas analyzer calibration kit has the following components:

a. **Calibration Gas Cylinder** - A single cylinder contains all gases necessary for calibration.

b. **Fittings** - All fittings necessary for attachment to the analyzer unit, flow regulation and flow indication.

c. **Carry Case** - The case contains all components of the calibration kit.

074-27.9 USE OF THE FOUR GAS ANALYZER

The following paragraphs describe the steps necessary for operation of the four gas analyzer:

074-27.9.1 PRE-CHECK. Prior to daily operation, the four gas analyzer unit shall be calibrated using the manufacturer's calibration gas. Refer to the manufacturer's technical manual for calibration procedures. In addition to the calibration check, the operator shall ensure the battery is charged and all components are in good condition. The sampling probe shall be visually inspected to verify that the water barrier, filter and ″O″ ring are in place.

074-27.9.2 TURN ON/OFF. The large black push-button on top of the analyzer unit is the Mode button. Depressing the button once turns the instrument on. Holding the Mode button down for three seconds turns the analyzer unit off.

074-27.9.3 OPERATION. After the analyzer unit is activated, a self-check is performed which lights up the display, sounds the alarm, identifies the sensors and tests the on-board computer. While there are several display options, the instrument should be set to show the current numerical readings. The Mode button can be used to display the current instantaneous readings, the peak readings since the analyzer unit was activated, a 15 minute time weighted average (TWA) (for comparison against the STEL) and a projected eight hour TWA (for comparison against the PEL). Additional operations information is contained in the manufacturer's technical manual.

074-27.9.4 METHODS OF SAMPLING. If the instrument is to be carried into the atmosphere to be monitored, the analyzer unit can measure gas concentration by diffusion. No pumps or sensing tube are required. The sensors are directly exposed to the atmosphere being measured. When remote sensing is required either the hand aspirator or the motor driven pump may be used. When using the hand aspirator, squeeze the bulb one time for each foot of hose (i.e., five squeezes for five feet of hose). When using the motor driven pump, wait two or three minutes for the sample to reach the sensors, then wait for the reading to stabilize at a constant value.

074-27.10 ACCURACY

After being calibrated, the analyzer is capable of measuring true gas concentration within the following tolerances:

Oxygen: +/- 0.5% by volume over the full range

Combustible gas: +/- 5.0% LEL or 10% of the gas concentration, whichever is greater

Carbon monoxide: +/- 5.0 ppm or 10% of the carbon monoxide concentration, whichever is greater

Hydrogen sulfide: +/- 5.0 ppm or 10% of the hydrogen sulfide concentration, whichever is greater

074-27.11 RANGES

Oxygen: 0-25% by volume

Combustible gas: 0-99% LEL

Carbon monoxide: 0-200 ppm

Hydrogen sulfide: 0-20 ppm

074-27.12 ALARM CONDITIONS

074-27.12.1 The analyzer unit is factory set to alarm at the following instantaneous gas concentration levels:

Low oxygen: 19.5%

High oxygen: 22.0%

Combustible gas: 10% LEL and above

Carbon monoxide: 35 ppm and above

Hydrogen sulfide: 10 ppm and above

The combustible gas and oxygen limits are set as required by federal law in 29 CFR 1915. The analyzer unit is set to alarm when instantaneous toxic gas levels reach the PEL, even though federal regulations allow eight hour exposure at the PEL.

074-27.13 CALIBRATION

The four gas analyzer has been designed for easy calibration without the use of manual adjustments. The analyzer must be calibrated before each day’s use.

a. Pressing the **Mode** button three times within two seconds will place the instrument in the **Auto-Calibration Mode**. Adjustments are made automatically by again pressing the **Mode** button. Auto-calibration is a two step procedure.
   1. In the first step the four gas analyzer is taken to an area where the atmosphere is fresh and a **Zero** adjustment is made automatically by pressing the **Mode** button.
   2. The second step is the sensor response or **Span** calibration adjustment. In this step the sensors are exposed to a known concentration of calibration gas. If necessary, the sensitivity or **Span** can be adjusted automatically. Use of these procedures for calibration is reserved for authorized personnel only.

b. Calibration procedures are discussed in detail in Chapter 3 of the manufacturer's Reference Manual.

c. The four gas analyzer does not require calibration by metrology labs. The flow indicator used with the calibration does not require calibration, but must be replaced when it fails.

074-27.14 MAINTENANCE

The Planned Maintenance System (PMS) provides required maintenance procedures. Additionally:

a. PMS is to be performed by a qualified GFE.

b. The components of the analyzer kit shall be inspected before each day's use. The inspection shall include a visual check of the sampling probe to ensure the water barrier, particle filter and ″O″ ring are installed. This can be done without disassembling the probe because the probe is made of clear plastic. The inspection shall also include a check of the expiration date on the calibration gas cylinder. Do not use a calibration gas cylinder which is beyond the marked expiration date.

APPENDIX A

GAS FREE ENGINEERING INFORMATION SOURCES (SHIPBOARD)

1. American Conference of Governmental Industrial Hygienists, Industrial Ventilation Manual
2. American Conference of Governmental Industrial Hygienists, ″Threshold Limit Values For Chemical Substances and Physical Agents″
3. American National Standards Institute (ANSI) Z86.1-1989
4. 29 CFR 1910, Occupational Safety and Health Standards (General Industry)
5. 29 CFR 1915, Safety and Health Regulations For Maritime Employment
6. 29 CFR 1926, Safety and Health Regulations For Construction
7. 29 CFR 1960, Basic Program Elements For Federal Employee Occupational Safety and Health Programs
8. Compressed Gas Association, Inc., Pamphlet G-7, Compressed Air For Human Respiration
9. Compressed Gas Association, Inc., Pamphlet G-7.1, Commodity Specification For Air
10. DOD Instruction 6050.5 DOD Hazardous Material Information System (HMIS). (The HMIS is distributed to all ships and is maintained by the safety officer. Hazardous components, physical properties, recommended safety, handling and storage procedures and proper spill response procedures are presented for each material.)
11. MIL-HDBK 200, Quality Surveillance Handbook for Fuels and Lubricants
12. National Fire Protection Association (NFPA) Publication 306, Control of Gas Hazards on Vessels
13. National Fire Protection Association (NFPA) Publication 325M, Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids
14. National Fire Protection Association (NFPA) NFPA No. 70, Chapter 5, National Electrical Code
15. NAVAIR INSTRUCTION 10340 (series), Maintaining Quality and Limiting Contamination of Aircraft Fuels
16. NAVEDTRA 10301, Aviation Boatswain’s Mate F-3 and -2 Rate Training Manual
17. NAVEDTRA 10304, Aviation Boatswain’s Mate F-1 and -C Rate Training Manual
18. NAVSEA S9086-VZ-STM-010, NSTM Chapter 651 (Super 9340), Commissary Equipment
19. NAVSEA 0901-LP-500-0005, Auxiliary Steam Turbines
20. NAVSEA 0920-LP-103-2010, Shipboard Level Maintenance, Probe Refueling Hardware
21. NAVSEA 0955-LP-026-8010, Double Probe Fueling System
22. NAVSEA 5100.3, (series) Mercury, Mercury Compounds and Components Containing Mercury or Mercury Compounds; Control of
23. NAVSEA MIL-HDBK-291(SH), Military Handbook, Cargo Tank Cleaning
24. NAVSEA OP-4, Volume 1, Ammunition Afloat
25. NAVSEA OP-5, Volume 1, Ammunition and Explosives Ashore
26. NAVSEA S6470-AA-SAF-010, U.S. Navy Gas Free Engineering Program Ashore

27. NAVSEA S9542-AA-MMO-010, Operation and Maintenance Procedures for Shipboard Aviation JP-5 Fuel Systems (Surface Ships)
28. NAVSEA S9593-A7-PLN-010, Shipboard Hazardous Materials/Hazardous Waste Management Plan
29. NAVSEA S9593-A9-PLN-010, Hazardous Material/Hazardous Waste Spill Contingency Plan
30. NAVSEA S9593-A9-PLN-010, Hazardous Materials/Hazardous Waste Spill Prevention, Control and Countermeasures (SPCC) Plan
31. NAVSEA S59593-A1-MAN-010, Shipboard Management Guide for Polychlorinated Biphenyls (PCB's)
32. NAVSEA S9086-CL-STM-010, NSTM Chapter 077, Personal Protection Equipment
33. NAVSEA S9086-CH-STM-010, NSTM Chapter 074, Volume 1, Welding and Allied Processes
34. NAVSEA S9086-CN-STM-020, NSTM Chapter 079, Volume 2, Damage Control - Practical Damage Control
35. NAVSEA S9086-CN-STM-030, NSTM Chapter 079, Volume 3, Damage Control, Engineering Casualty Control
36. NAVSEA S9086-CZ-STM-000, NSTM Chapter 090, Inspections, Tests, Records and Reports
37. NAVSEA S9086-GY-STM-010, NSTM Chapter 221, Boilers
38. NAVSEA S9086-G1-STM-020, NSTM Chapter 223, Volume 2, Submarine Storage Batteries Silver-Zinc Batteries
39. NAVSEA S9086-H7-STM-010, NSTM Chapter 262, Lubricating Oils, Greases, Specialty Lubricants and Lubrication Systems
40. NAVSEA S9086-KR-STM-010, NSTM Chapter 313, Portable Storage and Dry Batteries
41. NAVSEA S9086-QH-STM-010, NSTM Chapter 470, Shipboard BW/CW Defense and Countermeasures
42. NAVSEA S9086-RH-STM-010, NSTM Chapter 503, Pumps
43. NAVSEA S9086-RJ-STM-010, NSTM Chapter 504, Pressure, Temperature and Other Mechanical and Electromechanical Measuring Instruments
44. NAVSEA S9086-RK-STM-010, NSTM Chapter 505, Piping Systems
45. NAVSEA S9086-RW-STM-010, NSTM Chapter 516, Refrigeration Systems
46. NAVSEA S9086-SN-STM-010, NSTM Chapter 541, Ship Fuel and Fuel System
47. NAVSEA S9086-SP-STM-010, NSTM Chapter 542, Gasoline and JP-5 Fuel Systems
48. NAVSEA S9086-SX-STM-010, NSTM Chapter 550, Industrial Gases: Generating, Handling, and Storage
49. NAVSEA S9086-SY-STM-010, NSTM Chapter 551, Compressed Air Plants and Systems
50. NAVSEA S9086-S2-STM-010, NSTM Chapter 554, Forced-Draft Blowers
51. NAVSEA S9086-S3-STM-010, NSTM Chapter 555, Volume 1, Surface Ship Firefighting
52. NAVSEA S9086-S3-STM-020, NSTM Chapter 555, Volume 2, Submarine Firefighting
53. NAVSEA S9086-T8-STM-010, NSTM Chapter 593, Pollution Control
54. NAVSEA S9086-VD-STM-020, NSTM Chapter 631, Volume 2, Preservation of Ships in Service - Surface Preparation and Painting
55. NAVSEA S9086-V4-STM-010, NSTM Chapter 655, Laundry
56. NAVSEA S9806-G9-STM-010, NSTM Chapter 231, Propulsion and SSTG Steam Turbines

57. NAVSEA S9806-HB-STM-010, NSTM Chapter 233, Diesel Engines

58. NAVSEA S9806-HC-STM-010, NSTM Chapter 234, Marine Gas Turbines

59. NAVSEA S9806-HY-STM-010, NSTM Chapter 254, Condensers, Heat Exchangers and Air Ejectors

60. NAVSEA S9806-RQ-STM-010, NSTM Chapter 510, Heating, Ventilating, and Air Conditioning Systems for Surface Ships

61. NAVSEA S9806-RS-STM-010, NSTM Chapter 512, Fans

62. NAVSEA S9806-WK-STM-010, NSTM Chapter 670, Stowage, Handling and Disposal of Hazardous General Use Consumables

63. NAVSEA S9510-AB-ATM-010 (U), Volume 1, Nuclear Powered Submarine Atmosphere Control Manual

64. NIOSH Certified Equipment List (current edition), Department of Health and Human Services

65. NIOSH Publication 80-100 (January 1986), NIOSH ALERT: Request for Assistance in Preventing Occupational Fatalities in Confined Spaces.

66. NIOSH Publication 80-106 (December 1979), NIOSH, Criteria for a Recommended Standard, Working In Confined Spaces

67. NIOSH Publication 87-113, NIOSH, A Guide to Safety in Confined Spaces

68. NTTP 3-20.31, Surface Ship Survivability

69. OPNAVINST 3120.32 (series), Ships' Organization and Regulation Manual (SORM)

70. OPNAVINST 5090.1 (series), Environmental and Natural Resources Protection Manual

71. OPNAVINST 5100.19 (series), Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat

APPENDIX B

INTRODUCTION TO SHIPBOARD GAS FREE ENGINEERING

This appendix has been included to provide outline materials for teaching the basics of gas free engineering. Since this material can be used to make viewgraphs, there are no document titles, figure names, or page numbers on the following pages of Appendix B.

There are 12 viewgraphs which are listed below in the correct sequence:

1. Introduction to Shipboard Gas Free Engineering
2. Confined Spaces
3. Potential Hazards Exist From Environmental Factors Throughout the Ship-Oxygen Hazards
4. Potential Hazards Exist From Environmental Factors Throughout the Ship-Oxygen Hazards (Continued)
5. Potential Hazards Exist From Environmental Factors Throughout the Ship-Explosive Hazards
6. Potential Hazards Exist From Environmental Factors Throughout the Ship-Explosive Hazards (Continued)
7. Potential Hazards Exist From Environmental Factors Throughout the Ship-Toxic Hazards
8. Potential Hazards Exist From Environmental Factors Throughout the Ship-Toxic Hazards (Continued)-Gases Include:
9. Potential Hazards Exist From Environmental Factors Throughout the Ship-Toxic Hazards (Continued)-Vapor Hazards Include:
10. Instruments to Detect Hazards
11. Training and Proper Procedures Will Protect Against Hazards-Gas Free Engineering Procedure
12. Training and Proper Procedures Will Protect Against Hazards-Procedures to Help Shipmates in an Emergency

INTRODUCTION TO SHIPBOARD GAS FREE ENGINEERING

POTENTIAL HAZARDS EXIST FROM ENVIRONMENTAL FACTORS THROUGHOUT THE SHIP

- Oxygen Hazards
- Explosive Hazards
- Toxic Hazards

INSTRUMENTS TO DETECT HAZARDS

- Oxygen Sensors
- Explosive Meters
- Toxic Chemical Detectors
- Four Gas Analyzer

TRAINING AND PROPER PROCEDURES WILL REDUCE THE POTENTIAL HAZARDS

- Gas Free Engineering Procedures
- Procedures for Helping Shipmates in Emergency

CONFINED SPACES

- **Tanks and voids**
- **Seldom used compartments**
- **Holds or areas where access is restricted**
- **Not designed for continuous occupancy**
- **Likely to have altered oxygen content (CHT pump rooms/reefer machinery rooms)**

POTENTIAL HAZARDS EXIST FROM ENVIRONMENTAL FACTORS THROUGHOUT THE SHIP

OXYGEN HAZARDS

Oxygen hazards exist when changes to the normal oxygen content are significantly altered from 20.9 percent by volume

Oxygen deficiency Immediately Dangerous to Life and Health (IDLH) conditions exist below 19.5 percent

- **OXYGEN DEFICIENCY CAN BE CAUSED BY:**
  - **Combustion or fire**
  - **Oxidation or rusting**
  - **Displacement by other gas**
  - **Absorption by chemical compounds**
- **OXYGEN DEFICIENCY EFFECTS:**
  - **Drowsiness and nausea**
  - **Fast breathing and heartbeat**
  - **Unconsciousness leading to death**
  - **Death within minutes**

POTENTIAL HAZARDS EXIST FROM ENVIRONMENTAL FACTORS THROUGHOUT THE SHIP (Continued)

OXYGEN HAZARDS (Continued)

Oxygen enrichment is defined as concentrations above 22 percent by volume which cause an extreme fire hazard

- **OXYGEN ENRICHMENT CAN BE CAUSED BY:**
  - **Oxygen leaks**
  - **Chemical reaction which releases oxygen**
- **OXYGEN ENRICHMENT EFFECTS:**
  - **Increased risk of fire and explosion**
  - **Rapid burning of hair and clothing if ignited**

POTENTIAL HAZARDS EXIST FROM ENVIRONMENTAL FACTORS THROUGHOUT THE SHIP (Continued)

EXPLOSIVE HAZARDS

A flammable atmosphere exists when the three components of the fire triangle are present: Oxygen, Fuel and Source of Ignition

Critical Point is the range between Lower Explosive Limit (LEL) and Upper Explosive Limit (UEL) for the substance or fuel

POTENTIAL HAZARDS EXIST FROM ENVIRONMENTAL FACTORS THROUGHOUT THE SHIP (Continued)

EXPLOSIVE HAZARDS (Continued)

GASES INCLUDE:

- **Hydrogen sulfide and methane which are produced by natural decay of organic materials**
- **Acetylene, hydrogen from battery charging, carbon dioxide and other gases from working fluids and cleaning solvents**
- **Fuel vapors such as diesel, MOGAS, JP–5, JP–8, otto fuel and many others**

PARTICULATES INCLUDE:

- **Ordinary dust**
- **Flour and wood dust**
- **Other materials in dust form**

POTENTIAL HAZARDS EXIST FROM ENVIRONMENTAL FACTORS THROUGHOUT THE SHIP (Continued)

TOXIC HAZARDS

- **Toxic hazards are present throughout the ship and are potentially the most difficult to recognize, detect and protect against**
- **Concentrations of toxic chemicals in the air above the permissible exposure limit (PEL) are a threat**
- **Numerous hazardous chemicals exist aboard ship and new types are introduced every year**
- **Natural processes produce toxic gases such as Hydrogen sulfide**

POTENTIAL HAZARDS EXIST FROM ENVIRONMENTAL FACTORS THROUGHOUT THE SHIP (Continued)

TOXIC HAZARDS (Continued)

GASES INCLUDE:

- **Freon found in reefer spaces**
- **Hydrogen sulfide found where organic material is stored**
- **Carbon monoxide (product of incomplete combustion)**
- **Carbon dioxide (product of combustion)**
- **Acetylene in gas bottle storage spaces**
- **Phosgene gas produced by oxidation of an unsuspected freon leak in an air conditioning system**

POTENTIAL HAZARDS EXIST FROM ENVIRONMENTAL FACTORS THROUGHOUT THE SHIP (Continued)

TOXIC HAZARDS (Continued)
VAPOR HAZARDS INCLUDE:

SOLVENTS:

- **Acetone**
- **Butyl alcohol**

FUELS:

- **Otto fuel**
- **JP–5**

INSTRUMENTS TO DETECT HAZARDS

OXYGEN SENSORS

- **Remotely sense and safely detect oxygen content**
- **Above 22.0 percent oxygen content unsafe for entry**
- **Below 19.5 percent oxygen content unsafe for entry**

EXPLOSIVE METERS remotely sense and safely detect concentrations of explosive gases, vapors and dusts

TOXIC CHEMICAL DETECTORS remotely sense and safety detect presence of toxic gas hazards

- **Colorimetric Detectors**
- **Diffusion-type Detectors**

TRAINING AND PROPER PROCEDURES WILL PROTECT AGAINST HAZARDS

GAS FREE ENGINEERING PROCEDURES

- **The Gas Free Engineer (GFE/GFEA) will certify all confined spaces before any entry or work begins**
- **Observe the requirements of all posted Gas Free Certificates**
- **Request a retest if the space has changed or has been vacated for any length of time**
- **Observe safety rules and personnel protection equipment requirements at all times**
- **Never enter a space to rescue a victim without proper authority (over fifty percent of all fatalities are a result of breaking this rule)**
- **Train and retrain yourself in gas free procedures**

TRAINING AND PROPER PROCEDURES WILL PROTECT AGAINST HAZARDS (Continued)

PROCEDURES FOR HELPING SHIPMATES IN AN EMERGENCY

- **Do not enter a space to attempt to help**
- **Notify OOD regarding the casualty**
- **Call away a medical emergency**
- **Make sure ventilation equipment is operating**
- **Ensure no one enters the space until the rescue team arrives.**

APPENDIX C

SAMPLE GAS FREE ENGINEERING NOTEBOOK

074-C.1 PURPOSE OF NOTEBOOK

The information contained in this appendix is presented as an example for creating a ship-specific gas free engineering notebook. The purpose of the notebook is to provide a ready reference for shipboard gas free personnel who may need such information when **NSTM Chapter 074, Volume 3** is not readily available or when ship-specific details not covered in **NSTM Chapter 074, Volume 3** are required.

074-C.2 NOTEBOOK CONTENTS

The shipboard gas free engineering notebook should contain ship-specific data, modeled after the examples provided herein. The contents should be organized as follows:

A. SAMPLE, SHIP'S GAS FREE INSTRUCTION

USS _____(SHIP)_____ INSTRUCTION 9192.1

Subj: GAS FREE ENGINEERING, HOT WORK AND COLD WORK PROGRAM

Ref: (a) **OPNAVINST 5100.19C (NAVOSH Manual)**

(b) **NSTM Chapter 074, Volume 3 (Gas Free Engineering)**

(c) **NTTP 3-20.31 (Surface Ship Survivability)**

(d) _____(SHIP)_____ INST 9210.9 (Radiological Controls and Restrictions Associated With Entering Monitored Spaces, Ducts and Piping)

(e) **NSTM 631, Volume 1-3 (Preservation of Ships in Service)**

(f) _____(SHIP)_____ INST 5440.2 (SORM)

Encl: (1) Hot Work Requirements

(2) Cold Work Requirements

(3) Closed Compartment and Void/Tank Opening Request Form

(4) Hot and Cold Work Permit Request

(5) Navy Gas Free Certificate

(6) Hot Work Permit

(7) Cold Work Permit

(8) Post Fire Atmospheric Testing

(9) Designation Letter for Gas Free Engineer

(10) Designation Letter for Gas Free Assistant

(11) Designation Letter for Gas Free Petty Officer

(12) Sample Contractor Hot Work Permit

(13) Spaces Exempt from Hot Work Permit Requirements

(14) Industrial Hygiene Paint Inspection Checklist

1. **PURPOSE.** To establish precautionary measures, and delineate responsibilities and inspection requirements involving entry into closed or poorly ventilated spaces, hot work, cold work and other activities which may produce a hazardous environment.

2. **CANCELLATION.** _____(SHIP)_____ INST 9192.1 (prior series)

_____(SHIP)_____ INST 9920.1 (prior series)

3. **DISCUSSION.** No routine hazard, with the exception of ordnance, is as dangerous as the presence of potentially lethal atmospheres in ship's spaces. In many instances, potentially harmful gases or vapors are present in such a low concentration (parts per million (ppm)) that no adverse conditions are created. By design, a ship has many confined spaces (especially tanks and voids) in which a multitude of both toxic and non-toxic gas- or vapor-creating substances and operations are used in the normal operation of the ship. Hazardous atmospheres may be created that can explode or cause asphyxiation. Compounding the problem is that many gases or vapors are not detected by the human ability of smell and personnel attempting to save a fallen shipmate may themselves be overcome and killed by undetected vapors. It is for these reasons that every confined space must be gas free tested. This is known as gas free engineering. References (a) through (c) thoroughly explain the gas free engineering program. Hot and cold work are part of the gas free engineering program due to their associated hazards of fire, explosion and toxic fumes produced by the operations.

4. **POLICY.**

a. No person shall enter or attempt to enter any closed compartment or poorly ventilated space in (SHIP) until the gas free directions in this instruction have been complied with, and the danger of suffocation, toxic exposure or ignition of flammable gases have been eliminated or reduced to the lowest practical level.

b. No work involving hot work or cold work shall be done in _____(SHIP)_____ until the Gas Free Engineer or his authorized representatives have inspected the area of planned work. This inspection must indicate that applicable safety directions have been complied with, that personnel can work in the area without danger of toxic exposure or suffocation, and that the hot or cold work can be done without danger of fire or explosion. An adequate number of trained fire watches must be assigned to the area of hot work. Specific requirements for hot work are outlined in enclosure (1) and cold work and painting in enclosure (2).

c. No person shall enter or attempt to enter any closed compartment or poorly ventilated space in _____(SHIP)_____ until enclosure (3) has been completed to receive the necessary gas free services. No hot or cold work may commence until the appropriate permits have been issued following submission of enclosure (4).

d. The procedures and precautions provided in references (a) through (c) shall be strictly enforced. Spaces posted with Gas Free Certificates shall be retested at least every 8 hours.

e. All hands will be trained on gas free engineering, hot work and cold work precautions and procedures.

5. **DEFINITIONS.**

a. **Closed Compartments or Poorly Ventilated Spaces:** Includes any spaces that are not well ventilated or which have been closed for any appreciable length of time. This includes unventilated storerooms, blisters, double bottoms, tanks, cofferdams, condensers, pontoons, voids, cable trunks and oil sumps, for example. The term also includes spaces which are normally occupied or regularly occupied but which have been vacated and sealed due to damage or some other reason.

b. **Hot Work**: Includes work involving welding, flame cutting, the use of open flame equipment or any work involving heating of metal above 400°F. Spark producing operations such as grinding, wheel cutting and power sanding are usually not considered as hot work, except when, in the opinion of the Gas Free Engineer, circumstances necessitate such a classification. This term shall also be considered to include all other sources of flames, sparks or intense heat which could increase the hazard of explosion, such as a lighted cigarette, open flames, electric cooking apparatus, non–explosive–proof lights and electric motors.

c. **Cold Work**: Includes any process that may put toxic or explosive vapors into the atmosphere, such as chemical cleaning and spray painting. The following are examples of cold work:

(1) Use of any type spray painting rig

(2) Painting any space with rollers or brushes using greater than one gallon of paint

(3) Any use of Formula 150 primer

(4) Application of PRC deck covering or primer.

d. **In Way Of**: Within or on outside boundary of spaces containing flammable or explosive materials, or anywhere in the vicinity of such materials.

e. **Within**: In addition to its obvious meaning, the term also includes work performed from the outside of a space but which involves flame cutting, welding, riveting through the plating or which involves the possibility of heating to 400°F the inside face of the plating or any other metal within the space.

f. **Exterior Boundary**: The outer side of the plating surrounding a space or any metal work immediately next to it.

g. **In Vicinity Of**: Any location inside or outside the vessel where:

(1) Flammable or explosive materials are stored

(2) Dangerous amounts of materials or vapors from these flammable or explosive materials may collect due to broken containers, overflow seepage, air currents or other causes, and shall be considered "in the vicinity" of the materials which are the source of the danger. "In the vicinity" means "within the compartment" or "on the exterior boundary".

h. **Lower Explosive Limit (LEL)**: The level of concentration of a gas vapor, below which the mixture is too lean to burn and above which is within the explosive range.

i. **Immediately Dangerous to Life or Health (IDLH)**: A confined space whose atmosphere meets one or more of the following conditions:

(1) Flammable vapors at a concentration of 10% or greater of the LEL

(2) Oxygen content less than 19.5% or greater than 22%

(3) Toxicant levels high enough to cause impairment or irreversible health effects if exposed for 30 minutes

(4) The following will always be treated as IDLH until testing proves otherwise:

(a) Sewage holding tanks (CHT)

(b) Fuel tanks

Fuel tanks that can be adequately cleaned from outside of the tank, using hoses and stripping systems, can be made clean enough to no longer fall under IDLH restrictions. CHT tanks may only be entered and cleaned by contractors and marine chemists and will be turned over for ship's force entry after cleaning is complete. IDLH spaces may only be entered for emergency repairs with Commanding Officer approval following the requirements of reference (b).

j. **Safety Notations**: To minimize confusion and misunderstanding, only the safety notations listed below shall be used on the Gas Free Engineer's Certificates, records and Gas Free Log:

(1) NOT SAFE FOR PERSONNEL – NOT SAFE FOR HOT WORK. This classification is for the following conditions:

(a) Personnel are in danger of toxic exposure due to hydrocarbons or other gases in excess of the limits of toxicity, or likely to be given off under existing conditions, or in danger of suffocation due to lack of oxygen.

(b) There is a danger of fire or explosion in the space due to the existence of concentrations of flammable vapors within limits of flammability; or due to the presence of flammable gases or vapors under conditions existing; or due to the presence of flammable or explosive materials which are likely to be affected by hot work; or due to the fact that the surrounding spaces have not been protected as required.

(2) NOT SAFE FOR PERSONNEL WITHOUT PROTECTION – NOT SAFE FOR HOT WORK. This category is for the following conditions:

(a) Toxic materials, vapors or gases may be present or may evolve in the space but at levels less than IDLH, and within the approved capacity of prescribed respiratory protective devices and other personal protective equipment.

(b) Flammable vapors may be present or may evolve but at levels less than 10% LEL and controls can be installed to maintain levels below 10% LEL.

(c) There is danger of fire, explosion or excessive toxic levels in the presence of hot work in the space or from the boundary spaces, that have not been protected as required.

(d) Hot work is prohibited in the space or in the boundary spaces to the space from which a provisional certificate is issued.

(3) SAFE FOR PERSONNEL – NOT SAFE FOR HOT WORK. This classification is for the following conditions:

(a) Hydrocarbons or other gases are present in excess of the limits for hot work but the oxygen content of the air is sufficient for workers to enter for work not involving hot work.

(b) Hydrocarbons or other gases are not present in excess of the limits for hot work and the oxygen content is such that personnel may perform work not involving hot work, but the nature of the work to be performed is such that it is likely that hydrocarbons or other gases in concentrations exceeding the hot work limits will be released or generated.

(4) SAFE FOR PERSONNEL – SAFE FOR HOT WORK. This classification is for the following conditions:

(a) Hydrocarbons or other gases in excess of the limits of toxicity are not present and are not likely to arise under any working conditions. The oxygen content of the air is sufficient for personnel.

(b) Flammable or explosive materials or vapors have been removed or adequately protected and surrounding spaces have been protected as required.

(5) NOT SAFE FOR PERSONNEL INSIDE – SAFE FOR HOT WORK OUTSIDE. This classification is for the following conditions:

(a) A non–flammable (inert) gas has been introduced into the space and the concentration of the inert gas will not support combustion or life and adequate measures have been taken to isolate the space from occupied spaces and to ensure that it will remain isolated until the inert medium is removed.

(b) The space has been "pressed–up" to eliminate any atmosphere. The section on the certificate referring to "pressed–up" will have a space for the liquid used. This indicates that the space is entirely filled with non–hazardous liquid (usually water), a means has been provided to verify the liquid level and the absence of air pockets and the boundary spaces have been protected as required.

6. **RESPONSIBILITIES.**

a. The CO is responsible for a comprehensive gas free engineering program within the command. The commanding officer shall:

(1) Ensure that there is at least one trained, qualified and certified Gas Free Engineer on board. Qualification and certification requirements are specified in reference (b). The Gas Free Engineer shall be designated as the command's Gas Free Engineer (GFE), using enclosure (9).

(2) Ensure that gas free engineering practices are established and initiate directives applicable to this program.

b. The **Safety Officer** shall ensure that this program is evaluated for compliance and effectiveness annually. The checklist in Appendix B8–A of reference (a) may be used for this purpose. Painting sites will be inspected using enclosure (14), Industrial Hygiene Paint Inspection Checklist.

c. The **Gas Free Engineer (GFE)** shall ensure that:

(1) Sufficient officers and petty officers, E–6 and above, are trained, qualified and certified as Gas Free Engineering Assistants and sufficient petty officers, E–5 and above, as Gas Free Engineering Petty Officers are available to meet the requirements of the command. Enclosures (10) and (11) shall be used to designate Gas Free Engineering Assistants and Gas Free Engineering Petty Officers. Additional support may be obtained from qualified marine chemists, shore activity GFEs, or industrial hygienists that are certified as GFEs.

(2) All equipment required by reference (b) to properly conduct gas free engineering is aboard the ship, is inventoried routinely and is properly maintained.

(3) Gas Free Certificates are posted as necessary and retesting is conducted in a timely manner.

(4) Personnel and training aids are made available to divisions for training, upon request.

(5) Records of gas free space testing are kept for one year, per reference (b).

(6) A listing of all qualified GFE, GFEA and GFEPO is maintained, regularly updated, provided to the Senior Watch Officer and DCA and posted in Damage Control Central. At least one qualified GFEA or GFEPO must be assigned to each in–port duty section.

d. The **Hot and Cold Work Scheduling Supervisor** shall ensure that:

(1) All requests are promptly processed in the database.

(2) Hot and cold work conflicts are resolved quickly with all parties concerned. Hot work will normally take precedence over cold work in the same area.

(3) All hot workers listed on requests are qualified to conduct the work requested.

(4) Contractor's and Ship's Force work do not conflict.

e. The **Radiological Controls Officer** shall update and provide a listing of all spaces that require additional RADCON support and controls for entry in accordance with reference (d). Only the Reactor Officer, Chemistry Radiological Assistant or Propulsion Duty Officer may grant access to tanks and voids posted as "High Radiation Areas".

f. **Department Heads/Division Officers** shall ensure that:

(1) The GFE is notified and entry is permitted before any unventilated, non–occupied space or any sealed space is entered.

(2) The GFE is notified, via the daily hot and cold work schedule, before any hot or cold work is conducted anywhere on the ship, with particular attention to hot work on a bulkhead, overhead or deck adjacent to a space containing flammable or a potentially explosive atmosphere (such as JP–5 or CHT tanks or piping).

(3) The GFE is notified of the stowage in a new location of any hazardous or toxic material.

(4) Gas Free Engineering Certificates posted on spaces for which they are responsible are complied with at all times.

(5) Gas Free Engineering retesting of assigned spaces is accomplished prior to the end of the period for which a gas free certificate is valid. If a change is made to a space, the space shall be retested and recertified prior to any additional work in the space.

(6) Assigned personnel comply with the ventilation and space preparation and inspection requirements outlined in this instruction.

(7) Assigned personnel are trained on the gas free engineering program upon reporting and annually thereafter.

g. **All hands** shall:

(1) Notify department head/division officer prior to entering any unventilated, non–occupied space or any sealed space, verify that such a space was checked by a gas free engineer prior to entry and comply with the Gas Free Engineering Certificates posted outside the space.

(2) Notify department head/division officer and GFE before any new space is used to store hazardous or toxic material or any spill of hazardous or toxic material.

(3) Ensure that spaces are safe for hot or cold work and necessary portable ventilation is rigged in accordance with the requirements outlined in this instruction.

7. **PROCEDURES.**

a. Gas free engineering services are obtained by submitting enclosure (3) to request initial opening of confined spaces, tanks or voids. Hot work and cold work permits are requested by submitting enclosure (4). Neither of these requests certifies a space safe for entry or hot or cold work. They simply inform the chain of command of intent to make entry or perform work. Enclosures (5), (6) and (7) will authorize entry and commencement of work when all conditions are met.

b. The Opening Request, enclosure (3), will be posted at each access that is opened. All fittings opened must be logged open in the Closure Log in DC Central (J–7874). Gas Free Certificates, enclosure (5), will be posted next to the opening request where they are easily seen at the access. The opening request will remain posted and is valid as long as the space remains open. If the space is closed back up, a new request must be submitted to re–open it.

c. Gas Free Certificates, Hot Work Permits and Cold Work Permits are only valid for a maximum of eight (8) hours and an individual certificate may be extended for a total of 24 hours in 8–hour increments. A new certificate or permit must be issued each morning for jobs that can not be completed in one day.

d. Hot and cold work requests will be submitted to the Fire Marshal's office prior to the deadlines listed below in Table 074–C–1:

Table 074–C–1. HOT AND COLD WORK REQUEST SUBMITTAL DEADLINES

Mon – Thu	Swing (15–23) Mids (23–07)	1200 1200	Same day Same day
Tue – Fri	Days (07–15)	1200	Day prior
Fri	Swings and Mids	1000	Fri
Sat – Sun	All shifts	1000	Fri
Mon	Day	1000	Fri

e. Requests submitted late will be accommodated on a case–by–case basis, with priority given to ship's force emergent and shipyard and contractor work.

f. The Fire Marshal or Duty Fire Marshal will approve the summary of requests for a particular shift, lining out any cold work that conflicts with hot work unless a higher priority has been placed on a particular cold work job. Permits will be prepared and issued to personnel that report to the Fire Marshal's office in person to pick them up.

g. After a permit is issued, the work site must be inspected by a GFE, GFEA, GFEPO or Duty Fire Marshal. Work may not commence until all conditions are met and the permit is signed by the authorized inspector.

h. Gas Free Certificates will be issued by the GFE, GFEA or GFEPO as appropriate after completion of testing. Personnel must comply with all requirements noted on the certificate prior to entry. Initial and follow–on testing is scheduled as required through the GFE.

8. **EMERGENCIES.**

a. Response to toxic gas emergencies is covered in the Toxic Gas Bill, referenced SORM article. Confined space rescue is covered in Reference (b), Section 25, Emergency Rescue Procedures.

b. Post fire gas free testing may be conducted by any qualified Gas Free Engineering Personnel (GFEP) utilizing the guidance contained in enclosure (8) and Reference (b), Section 26. All gas free test equipment will be maintained in the forward gas free equipment locker (LOCATION) after gas free equipment locker (LOCATION) and drawn as necessary to support the emergency gas free testing. GFEP support while at General Quarters will be provided by specifically assigned personnel stationed at the above locations.

c. The GFEP must test the space for an explosive atmosphere. If an explosive atmosphere is present, EEBDs will be prohibited from use as emergency air for the victim(s). If an EEBD cannot be used, the victim(s) must be expeditiously removed from the IDLH atmosphere or provided an SCBA air supply.

d. The victim(s) must be transported out of the space by the quickest means which does not aggravate injuries and permits continued breathing air supply. The method selection must be based on the time required, victim's injuries and the ability for continued air supply to the victim from the respiratory equipment being used.

9. **TRAINING.**

a. Division officers are responsible for ensuring that assigned personnel are trained on the gas free engineering program. They shall arrange with the GFE for personnel and training aids to conduct this training. Records of such training shall be maintained.

b. Training will cover the following topics:

(1) How to identify confined/enclosed spaces

(2) Hazards encountered when entering confined/enclosed spaces

(3) Procedures for requesting gas free testing and services

(4) Duties and responsibilities of a fire watch

(5) Procedures for helping shipmates in an emergency

(6) Toxic Gas Bill

(7) Hot and cold work precautions and requirements

(8) Portable ventilation requirements

(9) Space painting requirements and precautions.

c. Training must stress to all personnel that if a person is seen unconscious in any space, no one is to enter that space without appropriate respiratory protective equipment and a backup assistant.

d. All gas free engineering personnel shall be retrained annually in the gas free engineering techniques and procedures.

e. All gas free engineering personnel must be qualified to perform cardiopulmonary resuscitation (CPR).

f. Toxic gas drills and toxic gas casualty rescue training will be conducted at least every six months.

10. **RECORDS.** The Gas Free Engineer shall maintain the following records:

a. Navy Gas Free Certificates issued for spaces inspected shall be maintained for 12 months.

b. Training and Qualification records for all personnel designated as assistants for the GFE. The individual's training record will reflect the satisfactory completion of the training required by references (a) and (b).

c. Copies of all hot and cold work permits issued shall be maintained for 6 months.

11. **REVIEW AND RESPONSIBILITY.** The Damage Control Assistant is responsible for the annual review and update of this instruction as required.

_____

Commanding Officer

Distribution:

ENCLOSURE 1
HOT WORK REQUIREMENTS

REF: **NSTM Chapter 074, Volume 1, Welding and Allied Processes.**

1. Hot work, both cutting and welding, may be performed only after the Gas Free Engineer, designated Gas Free Engineering Assistants or Petty Officers or Duty Fire Marshals have verified the safety of the space for the requested hot work job. The adjacent spaces will also be checked and verified safe. If any discrepancies are found, they must be corrected before work can begin by the division that has requested the permit. There will be a qualified and properly equipped fire watch posted at the hot work site. Hot work permit requests will be made using enclosure (4). Spaces exempt from hot work permit requirements are listed in enclosure (13).

2. NAVSEA OP–4, Ammunition Afloat, forbids performing hot work in or above any space containing ammunition. All ammunition must be removed from the space or locker to certify it safe for hot work. Hot work may be performed in spaces adjacent to or below ammunition storage areas so long as no hot work will be performed closer than five (5) feet from the shared bulkhead or deck. The Weapons Officer and Ordinance Handling Officer will be notified prior to performing hot work in the above situations.

3. An adequate number of Fire Watches will be provided to properly monitor all areas affected by the hot work. At a minimum, the following equipment will be provided:

a. Eye and facial protection against both flash and debris. Shade 6 or darker welding goggles or shields must be worn by all fire watches who will be exposed to the flash

b. Leather gloves

c. Portable water type fire extinguisher

d. 15 pound CO_2 bottle (if electronics are near)

e. Portable AFFF extinguisher (if class "B" materials are near and removal is impractical)

f. 1–1/2–inch hose with vari–nozzle as a secondary means of extinguishment available in the vicinity.

4. When the designated inspector has finished walkthrough of all the spaces affected by the hot work job and no discrepancies are found, the inspector will sign the Hot Work Permit, enclosure (5). Copies of this certificate will then be posted at each entrance to the area.

5. Hot work will be conducted according to the following guidelines:

a. All structures and equipment in the vicinity will be covered with welding cloth to protect them from burns.

b. All class "A" materials will be moved clear of the potential area of spark spread and removed from the vicinity of adjacent bulkheads or decks. This will normally be at least five (5) feet from the hot work site or bulkhead. Any oil or grease on or near the surfaces where hot work will be performed will be removed and the surfaces cleaned.

c. Hot work will not be conducted in the vicinity of class "B" materials if at all possible. If such work is unavoidable, the Gas Free Engineer must certify that proper precautions have been observed.

d. No hot work will be conducted in an area where fire fighting equipment has been disabled.

e. If necessary, additional fire watches will be posted in all affected spaces adjacent to the space where the hot work is actually occurring. Communications between the hot work space and adjacent fire watches will be

established and maintained throughout the hot work operation. The inspector will indicate if additional fire watches will be required.

f. Fire watches will immediately stop hot work if any unsafe condition is suspected to exist. In addition, if any unsafe condition exists, the DCA or Fire Marshal will immediately be contacted. In port, after working hours, the ACDO, PDO or Duty Fire Marshal will be contacted.

g. Fire watches must remain on station for 30 minutes after completion of hot work to ensure that no further danger exists. At the conclusion of the 30 minutes period, the fire watch will verify that all spaces affected by the hot work are safe from reflash and that all surfaces involved in the hot work are cool to the touch. If the area has not cooled, the fire watch will remain on station until it is cool to the touch. The fire watch will then sign the Gas Free Certificate or Hot Work Permit and return the permit to the TIC Shack.

6. Fire watches will normally be provided by the division requesting the hot work. Where no such qualified fire watch is available from the division, the parent department will provide qualified fire watches.

7. During shipyard availabilities, the contract may call for contractors to provide their own fire watches. Their welding supervisor will coordinate with the Fire Marshal for Hot Work Permit inspections and issue. Shipyards and contractors normally issue permits similar to enclosure (12). They normally will not station as many fire watches as ship's force would and may often have the hot worker act also as fire watch. (SHIP) may station additional ship's force fire watches for a contractor job if the command feels it is necessary to safely continue the work and the contractor cannot or will not post additional fire watches.

8. Alteration Installation Teams (AIT) and other Navy contractors will often require fire watch support. It is the responsibility of the department and division that is receiving the new equipment or alteration to request the necessary hot work support and services and to station their own fire watches.

ENCLOSURE 2
COLD WORK REQUIREMENTS

REF: **NSTM Chapter 631, Volumes 1–3, Preservation of Ships in Service**

1. Cold work operations can create flammable and/or toxic atmospheres depending on the type of chemical or paint and how and where it is applied. Because cold work can be **DANGEROUS** to the health of the workers and those personnel in the immediate vicinity, proper safety precautions must be followed and adequate training must take place.

2. Supervisors must ensure that personnel follow safety requirements including:

   a. Barricade as necessary

   b. Required tag–outs complete

   c. Sparkproof/explosion–proof tools used

   d. Firefighting equipment available and operational

   e. Appropriate PPE obtained and worn

   f. Required ventilation set up under direction of GFE

   g. A danger area established out to 25 feet from the operation. No hot work will be approved within 6 frames (24 feet) of a cold work area.

Supervisors will use enclosure (14) as guidance to ensure all safety requirements are met.

3. For interior operations, dilution ventilation is required. At least one complete air exchange is required every three minutes. Ventilation shall continue for at least one hour after the operation has been completed. Installed exhaust ventilation will not be used as paint could spread into the ducts and fumes spread to other spaces.

4. Explosion–proof tools and equipment must be used.

5. Spray painting requires the use of a supplied air respirator. Other painting operations may require the use of organic vapor respirators, at a minimum. Personnel must wear approved coveralls, chemical goggles and gloves and must apply barrier creams to exposed areas of the body.

6. All damage control space markings and safety placards must be covered up to prevent them from being painted over. A drawing will be made of all piping and ducts to map all markings that must be replaced after painting is complete.

7. Spray painting or chemical cleaning operations require frequent atmospheric testing. Testing should be conducted during work breaks. Operations will cease immediately if fumes are detected outside the operation area. Operations will not recommence until gas free testing has been conducted and fume levels have been reduced.

8. For touch–up painting involving less that one gallon of paint in well–ventilated areas, the following requirements must be met:

   a. Eye protection required, using goggles or face shields.

   b. Only a brush and a small container of paint may be used.

   c. Personnel applying the paint shall wear long–sleeved shirts or coveralls and gloves to prevent exposing skin to paint.

ENCLOSURE 3
CLOSED COMPARTMENT AND VOID/TANK OPENING REQUEST

__(Ship)__INST 9192.1

Closed Compartment and Void/Tank Opening Request

Date: ____________________

From: Division Officer, Ext: _______
To: Gas Free Engineer
Via: 1) Damage Control Assistant
2) Radiological Controls Officer

1. Permission is requested to enter:
____

2. Reason for entry: ______________________________
____
____

3. Time/date requested to be opened: ______________________________

4. Expected time/date to be closed: ______________________________

5. Names and rates of personnel to enter space:
____
____
____
____

6. Safety observer at access: ______________________________

7. Petty Officer in Charge: ______________________________

8. Tag-outs required to isolate the space or support work: ______________________________

____
Division Officer

Radiological controls REQUIRED/not required for entry.
** If radiological controls required, RADCON personnel must be present for initial opening

____
RCO, CRA, RLDO, EOOW OR PDO

Opening of space approved/disapproved

____
DCA, ADCA OR PDO

Reason for disapproval (if appl): ______________________________
____

NO ENTRY IS PERMITTED UNTIL SPACE HAS BEEN INSPECTED AND CERTIFIED BY GAS FREE ENGINEERING (AND RADCON, IF APPL) PERSONNEL. APPROVAL OF THIS REQUEST ONLY PERMITS INITIAL OPENING OF THE SPACE.

Gas Free Certificate number ______________ issued.

____
Gas Free Engineer

NOTE: Post copy of approved request at each access that will be opened

NOTE: DC Closure log entry required for each fitting opened to space. Call the DCWS at J-7874 to log the fittings open and closed.

NOTE: Remove all forms, log closed all fittings and report space closeout to the Fire Marshal's Office on completion of work.

ENCLOSURE 4
HOT AND COLD WORK PERMIT REQUEST

____(Ship)____INST 9192.1

HOT AND COLD WORK PERMIT REQUEST

DATE:

TYPE OF WORK	SHIFT	DATE	SPACE NUMBER	DEPT/DIV/WC	POC & PHONE #

DAY	SHIFTS	DEADLINE
MON	07-15 (DAY)	1000 FRI
TUE - FRI	07-15 (DAY)	1200 DAY PRIOR
MON - THU	15-23 (SWING) 23-07 (MID)	1200 SAME DAY 1200 SAME DAY
FRI	15-23 (SWING) 23-07 (MID)	1000 FRI 1000 FRI
SAT, SUN & HOLIDAYS	ALL	1000 FRI

RECEIVED BY: ______________ DATE/TIME: __________

DBASE ENTRY: ______________________________

ENCLOSURE 5
NAVY GAS FREE CERTIFICATE

(See Section 20, and Appendix D of **NSTM Chapter 079, Volume 2**).

____(SHIP)___INST 9192.1

ENCLOSURE 6
HOT WORK PERMIT

SERIAL NO: _____ DATE/TIME: _____

WORK TO BE PERFORMED: _____ WELDING _____ BRAZING _____ ARC CUTTING
_____ OXY/ACET CUTTING _____ GRINDING
_____ OTHER:

LOCATION: _____

TIME COMMENCING: _____ SECURING: _____

HOT WORKER: _____
NAME RATE DIV

FIRE WATCHES: _____ _____
NAME RATE DIV LOCATION ASSIGNED

_____ _____

_____ _____

NOTIFICATIONS:

THE WEAPONS OFFICER, ORDNANCE OFFICER OR DUTY WEAPONS OFFICER SHALL BE NOTIFIED OF ALL HOT WORK TO BE PERFORMED IN OR ADJACENT TO MAGAZINES.

HOT WORKER CERTIFICATION:

I CERTIFY THAT I AM FAMILIAR WITH AND WILL COMPLY WITH ALL SAFETY PRECAUTIONS PERTINENT TO THIS TYPE OF WORK.

_____
HOT WORKER

THE LOCATION WHERE THIS WORK IS TO BE PERFORMED HAS BEEN INSPECTED, NECESSARY PRECAUTIONS HAVE BEEN TAKEN, VENTILATION HAS BEEN RIGGED WHERE REQUIRED AND PERMISSION HAS BEEN GRANTED FOR THIS WORK.

PERMIT EXPIRES: _____
SPECIAL PRECAUTIONS: _____

_____
FIRE MARSHAL/ GAS FREE ENGINEER

NOTE: POST PERMIT AT WORK SITE. SUBMIT COPY TO FIRE MARSHAL'S OFFICE

FINAL CHECK: WORK AREA AND ALL ADJACENT AREAS TO WHICH SPARKS AND HEAT MIGHT SPREAD WERE INSPECTED 30 MINUTES AFTER THE WORK WAS COMPLETED AND WERE FOUND TO BE FIRE SAFE. THE EQUIPMENT AND STRUCTURES WORKED ON WERE COOL TO THE TOUCH.

_____
FIRE WATCH

TIME SECURED: _____

NOTE: RETURN PERMIT TO FIRE MARSHAL'S OFFICE WHEN WATCH SECURED.

NOTE: RETURN ALL FIRE WATCH EQUIPMENT TO PLACE OF ISSUE.

(SHIP) INST 9192.1

(SHIP) INST 9192.1

ENCLOSURE 7
COLD WORK PERMIT

SERIAL NO: _____ DATE/TIME: _____

WORK TO BE PERFORMED: _____ SPRAY PAINTING
_____ BRUSH/ROLLER PAINTING
_____ CHEMICAL CLEANING
_____ OTHER:

LOCATION: _____

TIME COMMENCING: _____ SECURING: _____

COLD WORK SUPERVISOR: _____
NAME RATE DIV J-DIAL

COLD WORKERS: _____
_____
_____

COLD WORKER CERTIFICATION:

I CERTIFY THAT I AM FAMILIAR WITH AND WILL COMPLY WITH ALL SAFETY PRECAUTIONS IN OPNAVINST 5100.19C AND NSTM 631 PERTINENT TO THIS TYPE OF WORK.

_____ _____ _____
COLD WORKER COLD WORKER COLD WORKER

THE LOCATION WHERE THIS WORK IS TO BE PERFORMED HAS BEEN INSPECTED AS FOLLOWS:

_____ NECESSARY VENTILATION HAS BEEN RIGGED AND SUFFICIENT EXHAUST FLOW HAS BEEN VERIFIED

_____ DAMAGE CONTROL MARKINGS HAVE BEEN COVERED OR A DRAWING PRODUCED TO SHOW MARKING LOCATIONS WHEN PAINTING COMPLETE

_____ SPACE HAS BEEN PREPARED FOR PAINTING IN ACCORDANCE WITH NSTM 631

_____ NO HOT WORK IS SCHEDULED WITHIN 10 FRAMES (40 FT) OF COLD WORK SITE

_____ GAS FREE TEST SERVICES HAVE BEEN SCHEDULED TO SUPPORT TESTING DURING THE FOLLOWING WORK

PERMIT EXPIRES: _____
SPECIAL PRECAUTIONS: _____
_____

_____
FIRE MARSHAL/GAS FREE ENGINEER

NOTE: POST PERMIT AT WORK SITE. SUBMIT COPY TO FIRE MARSHAL'S OFFICE

NOTE: A SEPARATE GAS FREE TEST CERTIFICATE MUST BE POSTED TO RECORD GAS FREE TEST RESULTS.

NOTE: ON COMPLETION OF WORK, REMOVE PERMIT AND REPORT COMPLETION TO THE FIRE MARSHAL'S OFFICE.

ENCLOSURE 8
POST-FIRE ATMOSPHERIC TESTING

HAZARDOUS ATMOSPHERES

REFERENCES:

(a) 29 CFR 1910.1000, OSHA Permissible Exposure Limits
(b) NWP 3-20.31, Surface Ship Survivability
(c) OPNAVINST 5100.19B, NAVOSH Program Manual for Forces Afloat
(d) COMDTINST M16616.6A, Chemical Data Guide for Bulk Shipment by Water
(e) Department of Defense Hazardous Material Information System (HMIS)
(f) NSTM Chapter 550, Industrial Gases: Generating, Handling and Storage
(g) NIOSH Pocket Guide to Chemical Hazards

COMMON HAZARD CHARACTERISTICS

HAZARD	ODOR	FLAM.	VAP. DENSITY	SOURCE	KILL METHOD
Carbon Monoxide (CO)	none	yes	lighter	incomplete combust drying paint	subtle asphyxiant
Carbon Dioxide (CO_2)	none	no	heavier	complete combust conf. & encl. spaces	blunt asphyxiant
Nitrogen Dioxide (NO_2)	pngt/acrid	no	heavier	post fire atm	choking agent
Hydrogen Sulfide (H_2s)	rotten eggs	yes	heavier	anaerobic organic decay	nerve agent
Methane (CH_4)	none	yes	lighter	acrobic organic decay	explodes
Ammonia (NH_3)	pngt	yes	lighter	cleaning gear urinals	choking agent
Hydrogen (H_2)	none	yes	lighter	rust * & batteries	explodes
Halon 1301 ($CBrF_3$)	none	no	heavier	installed spaces	blunt asphyxiant
R-12 (Freon)	none	no	heavier	A/C mach rooms reefers	blunt asphyxiant

Note: Many halons and refrigerants break down into choking agents when heated to approximately 900 ° F.
When heated with oxygen they may produce:
- Hydrogen fluoride (HF)
- Hydrogen chloride (HCL)
- Hydrogen bromide (HBr)

When heated with or without oxygen they may produce:
- Phosgene (COCl)

* Rust depletes oxygen in addition to producing hydrogen

Post-Fire Atmospheric Testing

A. Oxygen tests: 19.5 - 22%

B. Explosives: < 10 % of the LEL

C. Toxicants:

1. Required toxic tests after all fires:

Gas	Cause
carbon monoxide	incomplete combustion
carbon dioxide	complete combustion
hydrogen chloride	PVC, halons and freons
hydrogen cyanide	wool, urethane, acrylics

2. Required for class bravo fires:

Gas	Cause
Hydrocarbons	petroleum products

3. Required if Halon 1301 is used:

Gas	Cause
Hydrogen fluoride	neoprene, halons and freons

4. Recommended if Halon 1301 is used:

Gas	Cause
hydrogen bromide	halons and freons

5. Other post-fire gases:

Gas	Cause
nitrogen dioxide	urethane, hot fires
sulfur dioxide	rubber
hydrogen sulfide	rubber
formaldehyde	cellulose (paper, wood etc.)

(SHIP) INST 9192.1

ENCLOSURE 9
DESIGNATION LETTER FOR GAS FREE ENGINEER

From: Commanding Officer, USS (SHIP)

To:

Subj: DESIGNATION AS GAS FREE ENGINEER

Ref: (a) OPNAVINST 5100.19C, CHAPTER B8

(b) **NSTM Chapter 074, Volume 3**

(c) **NTTP 3-20.31**

1. In accordance with references (a) through (c), you are hereby designated as a USS (SHIP) Gas Free Engineer (GFE).

2. This designation is given in recognition of your completing the formal "Gas Free Engineering Service" school outlined in reference (b). You are advised to continue your study and comply with references (a) through (c) relative to the responsibilities of the Gas Free Engineer.

_____
Commanding Officer

Copy to:
Service Record
Gas Free Engineer
DCA

(SHIP) INST 9192.1

ENCLOSURE 10
DESIGNATION LETTER FOR GAS FREE ENGINEERING ASSISTANT

From: Commanding Officer, USS (SHIP)

To:

Subj: DESIGNATION AS GAS FREE ENGINEERING ASSISTANT

Ref: (a) OPNAVINST 5100.19C, CHAPTER B8

(b) **NSTM Chapter 074, Volume 3**

(c) **NTTP 3-20.31**

1. In accordance with references (a) through (c), you are hereby designated as a USS (SHIP) Gas Free Engineering Assistant (GFEA).

2. This designation is given in recognition of your completing the formal "Gas Free Engineering Service" school outlined in reference (b). You are advised to continue your study and comply with references (a) through (c) relative to the responsibilities of the Gas Free Engineering Assistant.

3. During the normal work day you shall perform your duties as directed by the ship's Gas Free Engineer. In a duty status you shall perform your duties as directed by the Duty Fire Marshal.

_____
Commanding Officer

Copy to:
Service Record
Gas Free Engineer
DCA

(SHIP) INST 9192.1

ENCLOSURE 11
DESIGNATION LETTER FOR GAS FREE ENGINEERING PETTY OFFICER

From: Commanding Officer, USS (SHIP)

To:

Subj: DESIGNATION AS GAS FREE ENGINEERING PETTY OFFICER

Ref: (a) OPNAVINST 5100.19C, CHAPTER B8

(b) **NSTM Chapter 074, Volume 3**

(c) **NTTP 3-20.31**

1. In accordance with references (a) through (c), you are hereby designated as a USS (SHIP) Gas Free Engineering Petty Officer (GFEPO).

2. This designation is given in recognition of your completing the formal "Gas Free Engineering Service" school outlined in reference (b). You are advised to continue your study and comply with references (a) through (c) relative to the responsibilities of the Gas Free Engineering Petty Officer.

3. During the normal work day you shall perform your duties as directed by the ship's Gas Free Engineer. In a duty status you shall perform your duties as directed by the Duty Fire Marshal.

_____
Commanding Officer

Copy to:
Service Record
Gas Free Engineer
DCA

ENCLOSURE 12
SAMPLE CONTRACTOR HOT WORK PERMIT

HOLD/COLD WORK PERMIT
NN274 (REV 1) (33-21-874)

1. HOTWORK	2. COLDWORK
3. DATE AND SHIFT OF PERMIT	
4. HOTWORK PERMISSION IS HEREBY GRANTED TO PERFORM ☐ WELDING ☐ BRAZING ☐ BURNING ☐ HEATER BARS ☐ STUD WELDING ☐ GRINDING OTHER (SPECIFY) ☐	
COLDWORK PERMISSION IS HEREBY GRANTED TO USE 5. TYPE OF MATL.	
6. QUANTITY OF MATL.	
7. LOCATION OF WORK TO BE PERFORMED	
8. DEPT. INVOLVED	
SAFETY PRECAUTIONS TO BE TAKEN: 9. CHECK-OFF FOR HOTWORK 1) Check area for: "No Hotwork" signs posted ☐ 2) Bulkhead and/or deck openings secured ☐ 3) Area clear of flammable or noncombustible items ☐ 4) Fire Watch requirements ☐ 5) Locate propane and oxygen cut-off valves ☐ 6) Fire Watch equipment requirements ☐ 7) Adequate ventilation ☐ 8) Location of emergency firefighting equipment ☐ 9) Structure and equipment in area protected ☐ 10) Fire catch required Yes ☐ No ☐	
10. COLDWORK - Post appropriate *NO HOT WORK* signs. Get adequate ventilation - cease operations if hot work interrupts - any doubt as to safety precautions *CONSULT YOUR SUPERVISOR*	
11.SAFETY CAN NUMBER	
12.SPECIAL REQUIREMENTS OR PRECAUTIONS	
13.HOT/COLDWORK OPERATOR	
DEPT. NO.	EMPLOYEE NO.
14. FIRE WATCH	
DEPT. NO.	EMPLOYEE NO.
15.CHEMIST'S WORK PERMIT REQUIRED ☐ YES ☐ NO	
16. REQUESTING SUPV.	17. WELDING SUPV.

ENCLOSURE 13
SPACES EXEMPT FROM HOT WORK PERMIT REQUIREMENTS

Hot work is routinely performed in the following spaces where appropriate work stands, curtains and vent hoods have been installed specifically for that purpose. These spaces are exempt from routine posting of hot work permits. However, hot work may be secured in these locations if cold work has been approved in adjacent areas or fueling operations or weapons loads are in progress. The securing of hot work in these locations during fueling or weapons movements may be waived by the Commanding Officer on recommendation from the GFE on a case–by–case basis.

COMPARTMENT #	COMPARTMENT
	Lower Nuclear Weld Shop
	Shipfitter Shop
	Machine Shop
	Aviation Engine Shop
	Aviation Structure Shop
	R–Div Pipe Shop
	A–Div Steam Heat Shop
	Upper Nuclear Weld Shop
	Arresting Gear Terminal Socket Pouring Room

(SHIP) INST 9192.1

ENCLOSURE 14
INDUSTRIAL HYGIENE PAINT INSPECTION CHECKLIST

DEPT/DIV _____ POINT OF CONTACT _____

DATE/TIME _____ SPACE _____

INSPECTOR _____

TYPE OF PAINT/PRIMER _____NSN _____-_____-_____-_____

Ref: (a) OPNAVINST 5100.19C NAVOSH Manual for Forces Afloat

(b) **NSTM Chapter 631, Volume 2, Preservation of Ships in Service – Surface Preparation and Painting**

		CIRCLE	
1.	Is an approved cold work chit posted?	YES	NO
2.	Is exhaust ventilation provided in the space? Ref (a) CH C18 para C1802.i	YES	NO
3.	If it is a spray painting operation, are the workers wearing supplied air respirators? Ref (a) Ch C18 para C1802.d	YES	NO
4.	If it is a hand painting operation, at a minimum, are air purifying respirators being worn? Are black organic vapor cartridges being used? Ref (a) Ch C18 para C1802.d	YES	NO
5.	Does each respirator user have a valid respirator card?	YES	NO
6.	Are personnel wearing adequate clean clothing and gloves to prevent skin contact with painting and cleaning materials? Ref (b) para 631-2.26	YES	NO
7.	Have workers been trained on the use of Material Safety Data Sheets (MSDS) and have they seen and read the MSDS for the material they are using? Ref (a) Ch C23 para C2303.a	YES	NO
8.	Comments: _____		

ACTION: Safety Department has stopped work due to the above deficiencies. When noted item(s) are corrected, return this form to Safety, 02-143-1-Q, J-7127, prior to resuming work, signed by your Division Officer.

NAME /RANK / TITLE: _____

SIGNATURE / DATE: _____

B. ACTIVE GAS FREE CHITS

Place all active gas free chits in Section B of your GFE notebook.

C. INACTIVE GAS FREE CHITS

Place all inactive gas free chits in Section C of your GFE notebook.

(SHIP) INST 9192.1

D. SAMPLE GAS FREE ENGINEERING PROCEDURAL WORKING GUIDE

Initials or N/A

A. Pre–Inspection Procedures

1. Review Closed Compartment Opening Request, if applicable. _____
2. Review for same/similar previous jobs. _____
3. Review supporting records, as applicable: _____
   a. DC plates _____
   b. DC book _____
   c. Sounding sheet (from same day) _____
   d. MSDS for known or suspected hazards _____
   e. Other (specify). _____
4. Assign Personnel, as appropriate: _____
   a. Compartment testing _____
   b. Fire watch(es) _____
   c. Attendant(s) _____
   d. Other (specify). _____
5. Determine ventilation requirements for assigned work. _____
6. GFE conduct a safety brief with all assigned personnel to include: protective clothing, respiratory protection, lighting, ventilation, harnesses, tools, rescue procedures, communications and symptoms of exposure to expected hazards.
7. Rope off or otherwise secure the vicinity of the compartment entrance to non–involved personnel. _____
8. In DC Closure Log, enter any DC fittings to be opened in violation of prescribed material condition of readiness. _____
9. If required, make entry into Engineering Log. _____
10. If an IDLH atmosphere is determined to exist, upon completion of the drop test, do not enter. Reventilate two complete air changes, then retest. CO's permission is required for emergency access. _____
11. Check–out. _____

SAMPLE GAS FREE ENGINEERING PROCEDURAL WORKING GUIDE (Continued)

Initials or N/A

B. Closed Compartment Opening and Testing Procedures

1. Secure smoking lamp and all hot work in vicinity of space. _____

2. Perform required situation maintenance PMS (R–checks) on test equipment. _____

3. Muster assigned personnel and don protective clothing. Don appropriate respiratory protective equipment in space adjacent to entrance while removing the access cover or breaking into the piping system. When post–opening test of the adjacent space's atmosphere is satisfactory, relax respiratory equipment requirements. _____

4. Establish ventilation as determined in Step A–5. _____

5. Conduct a visual inspection of compartment interior. _____

6. Retest atmosphere (drop test) at space entrance. _____

7. Conduct internal atmospheric tests. Sample the compartment to achieve a true picture (high, medium, low). _____

8. Issue GF certificate based on inspection and testing results. _____

NOTE

Work specified on the GF certificate may now proceed according to the safety requirements of the certificate.

9. Periodically inspect the work scene for compliance and safe operations. _____

C. Post–Inspection Procedures

1. Fire watch remain for 30 minutes (minimum) after completion of hot work. _____

2. Conduct final internal compartment inspection with requesting activity. _____

3. Secure access to the compartment. _____

4. Remove all GF certificates and file required copies. _____

5. Log compartment "Closed" in DC Closure Log/Engineering Log as applicable. _____

6. Restow all gear. _____

E. IDLH SPACE/EMERGENCY ENTRY CHECKLIST

A. PRE-ENTRY PROCEDURES	INITIALS OR N/A
1. Assemble emergency entry and rescue equipment (if not already staged):	
a. SAR/SCBA or SCBA, spare bottles and back-up units	
b. Safety harnesses and tending lines	
c. Protective coveralls, gloves and boots	
d. Gas free instruments	
e. Communication equipment	
f. Vertical extraction hoist, anchoring device and stretcher	
g. EEBDs.	
2. Determine number of SAR/SCBA or SCBA spare bottles required.	
3. Review supporting records as applicable and as time allows to determine obstacles and hazards:	
a. DC plates and general plans	
b. Gas free test history	
c. MSDS for known or suspected hazards.	
4. Muster required personnel:	
a. Primary Rescue Team (2 people)	
b. Secondary Rescue Team (2 people)	
c. Attendants (One per person entering. Minimum two)	
d. Rescue hoist line tenders	
e. Medical department representative and stretcher bearers	
f. Electrician.	
5. Set up boundary ventilation and toxic gas boundaries.	
6. Erect vertical rescue equipment.	
7. GFE conduct a safety brief with all assigned personnel to include: protective clothing, respiratory protection, lighting, ventilation, harnesses, tools, rescue procedures, communications and symptoms of exposure of expected hazards.	
8. When all applicable steps above are complete, request permission to enter from CO/CDO.	
B. EMERGENCY ENTRY/RESCUE PROCEDURES	
1. Secure smoking lamp and all hot work in vicinity of space.	
2. Start boundary ventilation.	
3. Don required respiratory protective equipment.	
4. Rescue personnel enter affected space.	
5. Locate victims, assess situation and identify potential hazards.	
6. Secure electrical equipment and circuits that pose a direct threat to rescuers.	
7. Provide air supply to victim (SAR/SCBA System, SCBA, EEBD or Oxygen).	
8. Check victim for other injuries.	
9. Remove victim from space.	
10. Secure source of toxic gas if possible.	
11. Commence ventilating affected space(s).	
12. Conduct atmospheric test of space(s) inside boundaries. If testing is SAT, relax respiratory protective equipment in the area.	
13. Conduct atmospheric testing of affected space(s).	
C. POST ENTRY PROCEDURES	
1. Shift to applicable sections of Gas Free Engineering Check-list.	
2. Stow rescue equipment or re-stage for immediate use.	
3. Relax boundaries.	
4. Update GF Certificate.	

F. CLOSED COMPARTMENT OPENING REQUEST FORM

FROM: Division Officer, Ext:
TO: Gas Free Engineer

1. Permission is requested to enter: _____

2. Reason for entry: _____

_____

3. Time/date requested to be opened: _____

4. Expected time/date to be closed: _____

5. Names/rates of personnel to enter space: _____

_____

_____

_____

_____

6. Safety observer at access: _____

7. Petty Officer in Charge: _____

8. Tag-outs required to isolate the space and support work: _____

_____

_____
Division Officer

_____

Opening of space approved / disapproved

_____
Gas Free Engineer

NOTE: NO ENTRY IS PERMITTED UNTIL THE SPACE HAS BEEN INSPECTED AND CERTIFIED GAS FREE BY GFEP. APPROVAL OF THIS REQUEST ONLY PERMITS INITIAL OPENING OF THE SPACE FOR VENTILATION AND TESTING. OBSERVE GAS FREE PRECAUTIONS WHEN OPENING THE SPACE.

NOTE: Post copy of approved request at each access that is opened

NOTE: Log all fittings opened in the DC Closure Log

NOTE: Remove all forms and log closed all fittings on completion of work

APPENDIX D

NAVY GAS FREE CERTIFICATION AND TEST LOG

The Navy Gas Free Certification and Test Log is provided here as Appendix D. The certificate shall be ordered from the stock system using the form number and NSN, which are OPNAV 5100/16 (5-91), NSN 0107-LF-011-7400. They are issued in pads of 100. Continuation page may be reproduced locally.

SERIAL # -1- NAVY GAS FREE CERTIFICATION AND TEST LOG

INITIAL CERTIFICATION

SHIP/UNIT/ACTIVITY: -2-

ITEM/COMPARTMENT/SPACE: -3-

TYPE OF OPERATION TO BE CONDUCTED: -4-

INITIAL DATE OF TEST: HOUR: -5- DATE: -6-

INITIAL EXPIRATION: HOUR: -7- DATE: -8-

VENTILATION REQUIRED: -9- YES NO

TYPE: -10-

INERTED GAS: -11- (gas)
OR
PRESSED UP WITH: -12- (liquid)

REQUIREMENTS/CONCLUSIONS/PRESCRIBED PRECAUTIONS/INSTRUCTIONS:
-13-

GAS FREE RELATED HOT WORK

POS QUALIFIED FIRE WATCHES ASSIGNED

LOCATIONS	PRINT NAME/RATE	SIGNATURE* (UPON COMPLETION)
-14-	-15-	-37-

TIME SECURED -36-

*FINAL CHECKUP: WORK AREA AND ALL ADJACENT AREAS TO WHICH SPARKS AND HEAT MIGHT SPREAD WERE INSPECTED 30 MINUTES AFTER THE WORK WAS COMPLETED AND WERE FOUND TO BE FIRE SAFE. THE EQUIPMENT AND STRUCTURES WORKED ON WERE COOL TO THE TOUCH.

I CERTIFY THAT I AM FAMILIAR WITH AND WILL COMPLY WITH ALL SAFETY PRECAUTIONS PERTINENT TO THIS TYPE OF WORK.

HOT WORK OPERATOR SIGNATURE -16-

HOT WORK SUPERVISOR -17-

FIRE MARSHAL -18-

TEST RESULTS

TESTS CONDUCTED AS REQUIRED		INITIAL TEST	1ST RETEST	2ND RETEST
OXYGEN		-19-	-38-	-53-
COMBUSTIBLE GAS		-20-	-39-	-54-
TOXIC TYPE:	-21-	-22-	-40-	-55-
TOXIC TYPE:	-23-	-24-	-41-	-56-
TOXIC TYPE:	-25-	-26-	-42-	-57-
TOXIC TYPE:	-27-	-28-	-43-	-58-

EXISTING CONDITIONS	INITIAL TEST	1ST RETEST	2ND RETEST
NOT SAFE FOR PERSONNEL/ NOT SAFE FOR HOT WORK	-29-	-44-	-59-
NOT SAFE FOR PERSONNEL WITHOUT PROTECTION/ NOT SAFE FOR HOT WORK	-30-	-45-	-60-
SAFE FOR PERSONNEL/ NOT SAFE FOR HOT WORK	-31-	-46-	-61-
SAFE FOR PERSONNEL/ SAFE FOR HOT WORK	-32-	-47-	-62-
NOT SAFE FOR PERSONNEL INSIDE/SAFE FOR HOT WORK OUTSIDE	-33-	-48-	-63-

NOTE: THIS INSPECTION INDICATES THE CONDITIONS WHICH EXISTED AT THE TIME TESTS WERE CONDUCTED.

GFE PERSONNEL SIGNATURE -34-

CO SIGNATURE, If required -35-

RECERTIFICATION

1ST RETEST/UPDATE

TIME: -49- DATE: -50- EXPIRES: -51-

GFE PERSONNEL SIGNATURE -52-

2ND RETEST/UPDATE

TIME: -64- DATE: -65- EXPIRES: -66-

GFE PERSONNEL SIGNATURE -67-

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Figure 074-D-1. NAVY GAS FREE CERTIFICATION AND TEST LOG (Sheet 1 of 2)

SERIAL # _____

NAVY GAS FREE CERTIFICATION AND TEST LOG
CONTINUATION PAGE (NEW)

CONTINUATION PAGE
SHIP/UNIT/ACTIVITY: -2-
ITEM/COMPARTMENT/SPACE: -3-
ADDITIONAL VENTILATION INFORMATION:
ADDITIONAL REQUIREMENTS/CONCLUSIONS PRESCRIBED PRECAUTIONS/INSTRUCTIONS:

RETEST
RETEST/UPDATE
TIME: DATE: EXPIRES:
OFF PERSONNEL SIGNATURE:
RETEST/UPDATE
TIME: DATE: EXPIRES:
OFF PERSONNEL SIGNATURE:
RETEST/UPDATE
TIME: DATE: EXPIRES:
OFF PERSONNEL SIGNATURE:

OPNAV 5100/15 (5/91)

TEST RESULTS				
TESTS CONDUCTED AS REQUIRED		RETEST	RETEST	RETEST
OXYGEN				
COMBUSTIBLE GAS				
TOXIC TYPE:				
TOXIC TYPE:				
TOXIC TYPE:				
TOXIC TYPE:				
TOXIC TYPE:				
TOXIC TYPE:				
EXISTING CONDITIONS		RETEST	RETEST	RETEST
NOT SAFE FOR PERSONNEL/ NOT SAFE FOR HOT WORK				
NOT SAFE FOR PERSONNEL WITHOUT PROTECTION/ NOT SAFE FOR HOT WORK				
SAFE FOR PERSONNEL/ NOT SAFE FOR HOT WORK				
SAFE FOR PERSONNEL SAFE FOR HOT WORK				
NOT SAFE FOR PERSONNEL INSIDE/ SAFE FOR HOT WORK OUTSIDE				

Figure 074-D-1. NAVY GAS FREE CERTIFICATION AND TEST LOG (Sheet 2 of 2)

APPENDIX E

(NEW) SHIPBOARD HAZARDOUS ATMOSPHERES AND COMPARTMENTS IDENTIFICATION TABLES

Appendix E presents two tables which provide guidance for identifying hazardous atmospheres and compartments aboard ship. While the data is not to be considered exhaustive, it is representative of those items and compartments aboard most ships which present off-gas hazards. Table 074-E-1 below identifies gas hazards for typical shipboard materials, along with a list of proper detecting devices of those gas hazards.

Table 074-E-1. HAZARDOUS ATMOSPHERE IDENTIFICATION TABLE

SOURCE OF MATERIAL	GAS HAZARD	DETECTION DEVICE
Acid	Hydrochloric Acid	Hydrochloric Acid Tube
Acrylic Plastics	Hydrogen Cyanide	Hydrocyanic Acid Tube
Adhesives		
AFFF Systems	Hydrogen Sulfide	Hydrogen Sulfide Detector
Alcohols	Ethylene Oxide	4-Gas Analyzer
Anaerobic Materials	Hydrogen Sulfide	Hydrogen Sulfide Detector
Antifreeze		
AVGAS	Octane	Hydrocarbons 2 Tube
Batteries	Hydrogen Gas/Sulfuric Acid Mist/ Sulfur Gases/Carbon Dioxide	Hydrogen/4-Gas Analyzer
Bulkhead Preserving Compounds	Carbon Monoxide	Carbon Monoxide Tube
Calcium Carbide	Acetylene	4-Gas Analyzer
Cellulose (Paper)	Formaldehyde	Formaldehyde Activation Tube
Chillwater Insulation, burnt	Hydrogen Cyanide	Hydrocyanic Acid Tube
Chlorine Laundry Bleach	Calcium Hypochlorite	Chlorine Tube
Class ″A″ Fire	Post Fire (See Section 26)	Instruments and Tubes
Class ″B″ Fire	Post Fire (See Section 26)	Instruments and Tubes
Class ″C″ Fire	Post Fire (See Section 26)	Instruments and Tubes
Class ″D″ Fire	Post Fire (See Section 26)	Instruments and Tubes
Cleaning Gear	Methane	4-Gas Analyzer
Complete Combustion	Carbon Dioxide	Carbon Dioxide Tube
Cotton	Acrolin	
Diesel Fuel	Benzene	4-Gas Analyzer
Diesel Fuel Marine (DFM)	Octane	Hydrocarbons 2 Tube/4-Gas Analyzer
Dry Ice	Carbon Dioxide	Carbon Dioxide Tube
Electrolysis in Seawater	Hydrochloric Acid	Hydrochloric Acid Tube
Ether	Ether	4-Gas Analyzer
FF System	Carbon Dioxide	Carbon Dioxide Tube
Freon, Halogens	Phosgene/Chlorine/Reduced 02	Phosgene Tube/02 Analyzer
Freon, heated	Hydrogen Fluoride/Reduced 02	Hydrogen Fluoride Tube/02 Analyzer
Halon 1301 decomposition/installed FF agent	Hydrogen Fluoride/Reduced 02	Hydrogen Fluoride Tube/02 Analyzer
Halon, Freon	Hydrogen Bromide/Reduced 02	Hydrogen Bromide Tube/02 Analyzer
HTH	Hydrochloric Acid	Hydrochloric Acid Tube
Hydrocarbon Solvents	Hydrocarbon	Hydrocarbon Tube
Incomplete Combustion	Carbon Monoxide	Carbon Monoxide Tube
JP Fuels	Octane	Hydrocarbons 2 Tube/4-Gas Analyzer
Kerosene	Benzene	4-Gas Analyzer

Table 074-E-1. HAZARDOUS ATMOSPHERE IDENTIFICATION TABLE -

Continued

SOURCE OF MATERIAL	GAS HAZARD	DETECTION DEVICE
Lagging	Hydrogen Cyanide	Hydrocyanic Acid Tube
Mercury	Mercury Vapor	Mercury Vapor Detector
Neoprene (Electrical Insulation)	Hydrogen Chloride	Hydrochloric Acid Tube
OBA Canisters	Elevated Oxygen Concentration	4-Gas Analyzer
Oil-type Paints		
Organic Decay	Hydrogen Sulfide Methane	Hydrogen Sulfide Detector Explosimeter
Paints/Solvents	Carbon Monoxide	Carbon Monoxide Tube
Pesticides		Petroleum Products
Petroleum Products	Hydrocarbons	Hydrocarbon 2 Tube
Phenolic Resin Binder		
Photo Chemicals		
Poly Vinyl Chloride Cable Jacketing*	Hydrogen Chloride	Vinyl Chloride Tube
PVC Cable*	Vinyl Chloride	Vinyl Chloride Tube
PVC	Hydrogen Chloride	Hydrochloric Acid Tube
R-12 Plant Refrigerant	Phosgen/Freon/Reduced 02	02 Analyzer/Halogen Leak Detector/ Phosgen Tube
Refrigerant	R-12 (Freon)	Freon Detector
Rubber	Sulfur Dioxide	
Rubber, organic material	Hydrogen Sulfide	Hydrogen Sulfide Detector
Rubber tubing, gaskets & seals	Sulfur Dioxide	Sulfur Dioxide Tube
Rust	Hydrogen	Explosimeter
Sewage Systems	Hydrogen Sulfide Ammonia	Hydrogen Sulfide Detector
Teflon	Fluorine Gas	
Urethane	Nitrogen OxidesHydrogen Cyanide	Nitrogen Dioxide TubeHydrocyanic Acid Tube
Urinals	Methane	None
Vinyl Nitrile Rubber Chilled Water Piping Insulation*	Hydrogen Cyanide	Hydrocyanic Acid Tube
Vinyl Nitrile Rubber Submarine Insulation*	Hydrogen Cyanide	Hydrocyanic Acid Tube
Water Treatment		
Welding Arcs	Nitrogen Dioxide	Nitrogen Dioxide Tube
Wool	Hydrogen CyanideCarbon Monoxide	Hydrocyanic Acid TubeCarbon Monoxide Tube
*When burned or burning, this material will produce the gas hazard byproduct listed.		

Table 074-E-2 provides guidelines for hazardous materials one can expect in the compartments listed below. Although not a complete list of every hazardous material found aboard every ship, Table 074-E-2 does describe compartment locations common to all surface ships.

Table 074-E-2. SHIPBOARD COMPARTMENT HAZARDOUS IDENTIFICATION TABLE

COMPARTMENT LOCATION	HAZARDOUS MATERIALS
AFFF Piping System	Hydrogen Sulfide

Table 074-E-2. SHIPBOARD COMPARTMENT HAZARDOUS

IDENTIFICATION TABLE - Continued

COMPARTMENT LOCATION	HAZARDOUS MATERIALS
After Steering	Hydraulic Fluids
Air Conditioning Machinery Room	Freon
Anchor Windlass	Hydraulic Fluids
Armory	Ammunitions/Grenades
Auxiliary Machinery Room (AMR)	Freon/Fuel (F-76)/2190 Lube Oil/Flammable Liquids Locker
Battery Charging Room/Compartments	Acid Batteries, Hydrogen Gas
Battle Dressing	Oxygen Gas Cylinders/Hydrogen Peroxide
Boat Shop/ICE Shop	Ether/Lube Oil/Fuel Oil
BT Storeroom	Bathythermograph (Lithium Batteries)
CHT Pump/Equipment Rooms	Hydrogen Sulfide/Methane/Raw Sewage
CIWS Control Room	Hydraulic Fluid
Calcium Hypochlorite Locker	Calcium Hypochlorite, Chlorine Gas
Fuel Compartments	Cargo Fuel
Gasoline Compartments	Gasoline
JP-5 Compartments	JP-5
Compressed Gas Cylinder Room	Nitrogen/Oxygen/Carbon Dioxide/Halon/Freon
Countermeasures Locker	Lithium Hydride
DC Repair Stations (DCRS)	PECU Oxygen Gas Cylinders
Diesel Generator Rooms	Fuel/Carbon Monoxide/Carbon Dioxide
Dry Cleaning Plant	Dry Cleaning Fluids
Electric Shop	Hydraulic Oil/Flammable Liquids Locker
Elevator Machinery Room	Hydraulic Fluids
Flammable Liquids Issue Room	Paints/Thinners/Greases/Oils/Halon 1301/CO_2 Extinguishers
Flammable Liquids Storeroom	Paints/Wash Primer Pretreatment/Shellac/Polyamide Epoxies/some Polyurethanes, Urethanes/Cellulose Nitrate Coatings/Aluminum Paste/Acetone/Butyl Acetate/Ethyl Acetate/Methyl Ethyl Ketone/ Methyl Isobutyl Ketone/Naptha/Lacquer Thinner/Toluene/Turpentine/ Isopropyl Alcohol/Ethyl Alcohol/Butyl Alcohol/Methyl Alcohol/Paint Issue Locker/Halon 1301/CO_2 Extinguishers
Flammable Liquids Locker	Paints/Oils/Greases
Fuel Pump/Filter Rooms	Fuel/Hydrocarbon Vapors
Generator Room	JP-5/Fuel (F-76)/HP-Air Flasks
IC Gyro Room	Acid Batteries
Inert Gas Cylinder Storeroom	Identified Inert Gas
JP-5 Pump Room	JP-5/AC Plant-Freon/HCL/HFL/Phosgene
Laundry and Storeroom	Chlorine Gas, Bleach
Loader Drum Room	Hydraulic Oil/Nitrogen Gas Cylinder
Log Room	Caustic Soda
Lubricating Oils Compartments	Lubricating Oils
Main Engine Room(s) (MER)	Fuel (F-76)/2190 Lube Oil/23699 Lube Oil/HP Air Flasks/ B+B 3100 Gas Path Cleaner/Flammable Liquids Locker
Medical Spaces/Ward	Oxygen Gas Cylinders/Potassium Hydroxide/Isopropyl Alcohol/Tincture of Benzoin/Hydrogen Peroxide/Silver Nitrate Sticks
Paint Locker	Carbon Monoxide/Hydrocarbon Vapors
Reefer and Reefer Machinery Room	Freon
Sewage Piping and Holding Compartments	Hydrogen Sulfide/Methane/Raw Sewage

Table 074-E-2. SHIPBOARD COMPARTMENT HAZARDOUS

IDENTIFICATION TABLE - Continued

COMPARTMENT LOCATION	HAZARDOUS MATERIALS
Shaft alley	2190 Lube Oil/Freon
Steering Gear Room	2135 Hydraulic Oil
Storerooms - Chemical	Calcium Hypochlorite/Hydrochloric Acid/Ammonia
Storerooms - Paper	Formaldehyde
Test Lab	Propane Cylinders, Reagents
Torpedo Magazine	Otto II Fuel/Helium
Towed Array Room	ISOBAR
Vacuum, Chemical Holding Tank (VCHT)	Hydrogen Sulfide Methane/Raw Sewage
Vertical Launch System	Missile Fuel
VOID Compartments	Off-gassing from rust
Windlass Machine Room	Hydraulic Fluid

APPENDIX F

HOW TO READ MATERIAL SAFETY DATA SHEETS

The Material Safety Data Sheet (MSDS) is often called the key to hazard communication and is the one place where you can find all the important information on a given chemical. An MSDS does not have to follow any specific format but each has to provide the same kind of information. The MSDS format most widely used is the sample DOD one illustrated as Figure 074-F-1. It is divided into eight sections, described below.

Important: Always be sure that you are using the latest version of an MSDS. The main source to obtain MSDSs is the DOD Hazardous Material Information System (HMIS) CD-ROM.

THE MSDS - SECTION BY SECTION

SECTION I - General Information

Section I, *General Information* tells you:

a. The chemical name and stock number

b. The name, address and phone number of the company which makes the chemical

c. The date the MSDS was prepared.

d. The MSDS serial number

e. The Hazardous Characteristic Code

SECTION II - Ingredients/Identity Information

Section II, *Ingredients/Identity Information*, lists:

a. Hazardous components of a chemical, including mixtures, by both scientific and common names.

b. Recommended safe exposure limits for workers. The most common limits are OSHA's Permissible Exposure Limit (PEL) and the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Value (TLV).The only time you won't see the exact chemical identity listed here is if it is a manufacturer's ″trade secret″. The exposure limits and other hazard and safety information must, however, still be provided.

SECTION III - Physical/Chemical Characteristics

Section III, *Physical/Chemical Characteristics*, may look very scientific, but the information in the section is actually very basic and important. It tells you what conditions will change the chemical's form. For example, these changes could affect the type and degree of the chemical's hazard. A chemical with a very high vapor pressure probably needs to be treated differently than one with a low vapor pressure. A high vapor pressure, which means the chemical evaporates quickly, will require better ventilation, and possibly a respirator and other protective measures. Here's what you'll find in Section III:

a. Boiling point and melting point

b. Vapor pressure, vapor density and evaporation rate

c. Solubility in water and specific gravity

d. Chemical appearance and odor

SECTION IV - Fire and Explosion Hazard Data

Section IV of the MSDS, *Fire and Explosion Hazard Data*, is an extremely important section which provides you with:

a. The chemical's flash point

b. The chemical's flammable or explosion limits

c. Extinguishing media

d. Special firefighting procedures

SECTION V - Reactivity Data

Section V, *Reactivity Data*, shows whether you need to be concerned about what could happen (the reaction) if the chemical is mixed with air, water or other chemicals. It also explains what conditions and chemicals to avoid.

SECTION VI - Health Hazard Data

Section VI, *Health Hazard Data*, delivers crucial information to help keep you safe.

a. Route of entry (inhalation, ingestion, etc.)

b. Type of exposure (acute or chronic)

c. Signs and symptoms of exposure

d. Whether the chemical is a carcinogen (cancer causing)

e. Emergency/first aid procedures

SECTION VII - Precautions for Safe Handling and Use

Section VII, *Precautions for Safe Handling and Use*, provides instructions for the correct way to handle, store and dispose of the chemical. There is also information on what to do if the chemical spills, leaks or is released into the air. Naturally, you need to know this information before you start the job!

SECTION VIII - Control Measures

The final section, Section VIII, is *Control Measures*. This is where you will find out what type of protective clothing and equipment to use when working with the chemical. You will also see what type of ventilation is called for and what work and hygiene practices - such as washing your hands after working with the chemical - you need to follow to prevent accidental exposure.

You do not have to worry about remembering exactly what information is in what section of an MSDS. What is important is knowing that the MSDS information can help keep you safe if you use it. Check the MSDS before you start a job using a hazardous chemical and follow its instructions. Figure 074-F-1 gives an example of an MSDS included in the DOD Hazardous Materials Information System.

DOD Hazardous Materials Information System
DOD 6050.54–LR
as of April 1996
Proprietary Version – For U.S. Government Use Only

FSC: 6810

NIIN: 002904166

Manufacturer's CAGE: 29700

Part No. Indicator: A

Part Number/Trade Name: XYLENE

General Information (Section I)

Item Name: XYLENE, TECHNICAL

Company's Name: EXXON CHEMICAL AMERICAS A DIV OF EXXON CHEMICAL CO.

Company's Street: N/K

Company's P.O. Box 3272

Company's City: Houston

Company's State: TX

Company's Country: US

Company's Zip Code: 77001

Company's Emerg Ph#: 713–870–6000/800–424–9300(CHEMTREC)

Company's Info Ph: 713–870–6885

Distributor/Vendor #1: CSD INC. (409–756–1065)

Distributor/Vendor #1 Cage: 4N760

Distributor/Vendor #2: EXXON CHEMICAL AMERICAS A DIV OF EXXON CHEMICAL CO.

Distributor/Vendor #2 Cage: 72190

Distributor/Vendor #3:

Distributor/Vendor #3 Cage:

Distributor/Vendor #4:

Distributor/Vendor #4 Cage:

Safety Data Action Code:

Safety Focal Point: D

Record No. For Safety Entry: 002

Tot Safety Entries This Stk#: 006

Status: SE

Report for NIIN: 002904166

Figure 074-F-1. DOD Hazardous Materials Information System (Sheet 1 of 5)

Data MSDS Prepared: 01AUG91

Safety Data Review Date: 01OCT93

Supply Item Manager: CX

MSDS Preparer's Name:

Preparer's Company

Preparer's St. or P.O. Box:

Preparer's City:

Preparer's State:

Preparer's Zip Code:

Other MSDS Number:

Specification Number:

Spec Type, Grade, Class:

Hazard Characteristic Code: F4

Unit of Issue: DR

Unit of Issue Container Qty: 54 GAL

Type of Container: DRUM

Net Unit Weight: 391.3 LBS

NRC/State License Number: N/R

Net Explosive Weight:

Net Propellant Weight–Ammo: N/R

Coast Guard Ammunition Code:

Ingredients/Identity Information (Section II)

Proprietary:

Ingredient:

Ingredient Sequence Number:

Percent:

Ingredient Action Code:

Ingredient Focal Point:

NIOSH (RTECS) Number:

CAS Number:

OSHA PEL:

ACGIH TLV:

Report for NIIN: 002904166

Other Recommended Limit:

Figure 074-F-1. DOD Hazardous Materials Information System (Sheet 2 of 5)

Physical/Chemical Characteristics (Section III)

Appearance and Odor: CLEAR, COLORLESS LIQUID. AROMATIC ODOR.

Boiling Point: 279F, 137C

Melting Point: –65F FZ PT

Vapor Pressure (MM Hg/70F): 25 MMHG

Vapor Density (Air=1): 3.7

Specific Gravity: 0.87

Decomposition Temperature: UNKNOWN

Evaporation Rate and Ref: 0.7 (BUTYL ACETATE=1)

Solubility in Water: NEGLIGIBLE

Percent Volatiles by Volume: 100

Viscosity:

pH: N/K

Radioactivity:

Form (Radioactive Matl):

Magnetism (Milligauss): N/P

Corrosion Rate (IPY): UNKNOWN

Auto–Ignition Temperature:

Fire and Explosion Hazard Data (Section IV)

Flash Point: 80.0F, 26.7C

Flash Point Method: TCC

Lower Explosive Limit: 1.0

Upper Explosive Limit: 7.0

Extinguishing Media: USE FOAM OR DRY CHEMICAL

Special Fire Fighting Proc: WEAR FIRE FIGHTING PROTECTIVE EQUIPMENT AND A FULL FACED SELF CONTAINED BREATHING APPARATUS. COOL FIRE EXPOSED CONTAINER WITH WATER SPRAY.

Unusual Fire and Expl Hazards: COMBUSTION OR HEAT OF FIRE MAY PRODUCE HAZARDOUS DECOMPOSITION PRODUCTS AND VAPORS.

Report for NIIN: 002904166

Figure 074-F-1. DOD Hazardous Materials Information System (Sheet 3 of 5)

Reactivity Data (Section V)

Stability: YES

Cont to Avoid (Stability): TEMPERATURES ABOVE AMBIENT, SPARKS, OPEN FLAME AND OTHER SOURCES OF IGNITION

Materials to Avoid: STRONG OXIDIZING AGENTS, CONCENTRATED NITRIC AND SULPHURIC ACIDS, HALOGENS AND MOLTEN SULPHUR.

Hazardous Decomp Products: FUME, SMOKE, CARBON MONOXIDE

Hazardous Poly Occur: NO

Conditions to Avoid (Poly): NOT APPLICABLE

Health Hazard Data (Section VI)

LD50 – LC50 Mixture: LD50 ORAL RAT IS >5 G/KG

Route of Entry – Inhalation: YES

Route of Entry – Skin: YES

Route of Entry – Ingestion: NO

Health Haz Acute and Chronic: ACUTE: EYE AND RESPIRATORY TRACT IRRITATION. CENTRAL NERVOUS SYSTEM EFFECTS. LIQUID ASPIRATED INTO LUNGS DURING INGESTION MAY CAUSE PULMONARY INJURY AND POSSIBLE DEATH. SKIN: IRRITATION. CHRONIC: DERMATITIS. TARGET ORGANS: LUNGS, CNS.

Carcinogenicity – NTP: NO

Carcinogenicity – IARC: NO

Carcinogenicity – OSHA NO

Explanation Carcinogenicity: NONE OF THE INGREDIENTS IN THIS PRODUCT IS LISTED BY NTP, IARC OR OSHA AS A CARCINOGEN.

Signs/Symptoms of Overexp: EYES: IRRITATION. SKIN: DEFATTING OF SKIN, IRRITATION ON PROLONGED/REPEATED CONTACT. INHALATION: RESPIRATORY TRACT IRRITATION, HEADACHE, DIZZINESS, DROWSINESS.

Med Cond Aggravated by Exp: INDIVIDUALS WITH A HISTORY OF RESPIRATORY DISORDERS MAY BE AT INCREASED RISK FROM EXPOSURE.

Emergency/First Aid Proc: EYES: FLUSH WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. IF IRRITATION PERSISTS, SEE DOCTOR, SKIN: WASH WITH SOAP AND WATER WHILE REMOVING CONTAMINATED CLOTHING AND SHOES. INHALATION: REMOVE VICTIM TO FRESH AIR. GIVE OXYGEN/CPR IF NEEDED, GET MEDICAL HELP. INGESTION: DO NOT INDUCE VOMITING. GET MEDICAL HELP IMMEDIATELY.

Report for NIIN: 002904166

Figure 074-F-1. DOD Hazardous Materials Information System (Sheet 4 of 5)

Precautions for Safe Handling and Use (Section VII)

Steps If Matl Released/Spill: REMOVE PERSONNEL. ELIMINATE IGNITION SOURCES. VENTILATE AREA. WEAR PROTECTIVE EQUIPMENT. DIKE, RECOVER FREE LIQUID. USE EXPLOSION-PROOF EQUIPMENT. ABSORB RESIDUE IN INERT MATERIAL AND PLACE IN APPROPRIATE DISPOSAL CONTAINER AND COVER.

Neutralizing Agent: NOT APPLICABLE

Waste Disposal Method: DISPOSE OF IN ACCORDANCE WITH ALL FEDERAL, STATE AND LOCAL REGULATIONS.

Precautions-Handling/Storing: STORE IN COOL, DRY, WELL VENTILATED AREA. PROTECT FROM PHYSICAL DAMAGE, HEAT, IGNITION SOURCES AND INCOMPATIBLE MATERIALS. KEEP CONTAINERS CLOSED.

Other Precautions: AVOID EYE AND SKIN CONTACT. DO NOT BREATHE VAPORS.

Control Measures (Section VIII)

Respiratory Protection: NONE NORMALLY REQUIRED. NIOSH APPROVED RESPIRATOR OR SCBA AS APPROPRIATE FOR EXPOSURE OF CONCERN.

Ventilation: MECHANICAL (GENERAL) VENTILATION TO KEEP EXPOSURE LEVELS BELOW PEL. USE EXPLOSION-PROOF EQUIPMENT.

Protective Gloves: NITRILE GLOVES

Eye Protection: CHEMICAL SAFETY GOGGLES

Other Protective Equipment: PROTECTIVE CLOTHING AS REQUIRED TO MINIMIZE EXPOSURE FROM PROLONGED OR REPEATED CONTACT. EYE BATH AND SAFETY SHOWER.

Work Hygienic Practices: WASH THOROUGHLY AFTER HANDLING AND BEFORE EATING. LAUNDER CONTAMINATED CLOTHING BEFORE REUSE.

Suppl. Safety & Health Data: NONE

Figure 074-F-1. DOD Hazardous Materials Information System (Sheet 5 of 5)

APPENDIX G

PERMISSIBLE EXPOSURE LIMITS (PEL)

IDLH = Immediately Dangerous to Life or Health. (Data extracted from NIOSH Pocket Guide to Chemical Hazards, June 1994)

ND = Indicates that an IDLH has not as yet been determined.

PEL = permissible exposure limits are time-weighted average (TWA) concentrations that must not be exceeded during any 8-hour work shift of a 40-hour work week. PELs in the table originate from either OSHA (CFR 29) or Navy OELs (Occupational Exposure Limits), whichever is more stringent per OPNAVINST 5100.19.

NOTE

Although PELs are based on and similar to the threshold limit values on a time-weighted average (TLV-TWA) published by the ACGIH, PELs cover a wider range of substances and are incorporated in the Code of Federal Regulations (CFR) giving them the force of law.

(C) = Ceiling concentrations which must not be exceeded during any part of the workday.

Ca = Any substance that NIOSH considers to be a potential occupational carcinogen.

ppm = Parts per million parts of air.

mg/m^3 = Milligrams per cubic meter of air.

Exposure Limits

Chemical Name	PEL	IDLH
Acetaldehyde	100 ppm per OEL/Abandoned PELs	2,000 ppm (Ca)
Acetic acid	10 ppm	50 ppm
Acetic anahydride	5 ppm	200 ppm
Acetone	750 ppm per OEL/Abandoned PELs	2,500 ppm (LEL)
Acetonitrile	40 ppm	500 ppm
2- Actylaminofluorene	Ca	ND (Ca)
Acetylene tetrabromide	1 ppm	8 ppm
Acrolein	0.1 ppm	2 ppm
Acrylamide	0.03 mg/m^3	60 mg/m^3 (Ca)
Acrylonitrile	2 ppm/10 ppm (C)	85 ppm (Ca)
Aldrin	0.25 mg/m^3	25 mg/m^3 (Ca)
Allyl alcohol	2 ppm	20 ppm
Allyl chloride	1 ppm	250 ppm
Allyl gycidyl ether	5 ppm per OEL/Abandoned PELs	50 ppm
4-Aminodiphenyl	Ca	ND (Ca)
2-Aminopyridine	0.5 ppm	5 ppm
Ammonia	50 ppm	300 ppm

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Ammonium sulfamate	10 mg/m^3 per OEL/Abandoned PELs	1,500 mg/m^3
n-Amyl acetate	100 ppm	1,000 ppm
sec-Amyl acetate	125 ppm	1,000 ppm
Aniline and homologs	2 ppm per OEL/Abandoned PELs	100 ppm (Ca)
Anisidine (o- p- isomers)	0.5 mg/m^3	50 mg/m^3
Antimony and compounds	0.5 mg/m^3	50 mg/m^3
ANTU	0.3 mg/m^3	100 mg/m^3
Arsenic	0.010 mg/m^3	5 mg/m^3 (as As) (Ca)
Arsine	0.05 ppm	3 ppm (Ca)
Asbestos	0.1 $Fiber/cm^3$	ND (Ca)
Azinphos-methyl	0.2 mg/m^3	10 mg/m^3
Barium (soluable compounds as Ba)	0.5 mg/m^3	50 mg/m^3
Benzene	1 ppm per OEL/Abandoned PELs	500 ppm (Ca)
Benzidine	Ca	ND (Ca)
Benzoyl peroxide	5 mg/m^3	1,500 mg/m^3
Benzyl chloride	1 ppm	10 ppm
Beryllium (and compounds as Be)	0.002 mg/m^3 0.005 mg/m^3 (C)	4 mg/m^3
Boron oxide	10 mg/m^3 per OEL/Abandoned PELs	2,000 mg/m^3
Boron trifluoride	1 ppm (C)	25 ppm
Bromine	0.1 ppm	3 ppm
Bromoform	0.5 ppm	850 ppm
1,3-Butadiene	1 ppm per OSHA PEL and OEL/ Abandoned PELs	2,000 ppm (Ca) (LEL)
2-Butanone	200 ppm	3,000 ppm
2-Butoxyethanol	25 ppm per OEL/Abandoned PELs	700 ppm
n-Butyl acetate	150 ppm	1,700 ppm (LEL)
sec-Butyl acetate	200 ppm	1,700 ppm (LEL)
tert-Butyl acetate	200 ppm	1,500 ppm (LEL)
n-Butyl alcohol	50 ppm (C) per OEL/Abandoned PELs	1,400 ppm (LEL)
sec-Butyl alcohol	100 ppm per OEL/Abandoned PELs	2,000 ppm
tert-Butyl alcohol	100 ppm	1,600 ppm
n-Butylamine	5 ppm (C)	300 ppm
tert-Butyl chromate	0.1 mg/m^3 (C)	15 mg/m^3 (as Cr [VI]) (Ca)
n-Butyl glycidyl ether	25 ppm per OEL/Abandoned PELs	250 ppm
n-Butyl mercaptan	0.5 ppm	500 ppm
p-tert-Butyltoluene	10 ppm	100 ppm
Cadmium dust fume	0.005 mg/m^3	9 mg/m^3 (as Cd) (Ca)
Calcium arsenate	0.002 mg/m^3	5 mg/m^3 (as As) (Ca)
Calcium oxide	5 mg/m^3	25 mg/m^3
Camphor (synthetic)	2 mg/m^3	200 mg/m^3
Carbaryl	5 mg/m^3	100 mg/m^3
Carbon black	3.5 mg/m^3	1,750 mg/m^3
Carbon dioxide	5,000 ppm	40,000 ppm
Carbon disulfide	4 ppm per OEL/Abandoned PELs	500 ppm

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Carbon monoxide	35 ppm per OEL/Abandoned PELs	1,200 ppm
Carbon tetrachloride	10 to 20 ppm per OEL/Abandoned PELs	200 ppm (Ca)
Chlordane	0.5 mg/m^3	100 mg/m^3 (Ca)
Chlorinated camphene	0.5 mg/m^3	200 mg/m^3 (Ca)
Chlorinated diphenyl oxide	0.5 mg/m^3	5 mg/m^3
Chlorine	0.5 ppm per OEL/Abandoned PELs	10 ppm
Chlorine dioxide	0.1 ppm	5 ppm
Chlorine trifluoride	0.1 ppm (C)	20 ppm
Chloroacetaldehyde	1 ppm (C_3)	45 ppm
Alpha-Chloroacetophenone	0.05 mg/m^3 per OEL/Abandoned PELs	15 mg/m^3
Chlorobenzene	75 ppm	1,000 ppm
o-Chlorobenzylidene malononitrile	0.05 ppm (C)	2 mg/m^3
Chlorobromomethane	200 ppm	2,000 ppm
Chlorodiphenyl (42% chlorine)	1 mg/m^3	5 mg/m^3 (Ca)
Chlorodiphenyl (54% chlorine)	0.5 mg/m^3	5 mg/m^3 (Ca)
Chloroform	2 ppm per OEL/Abandoned PELs	500 ppm
bis-Chloromethyl ether	Ca	ND (Ca)
Chloromethyl methyl	Ca	ND (Ca)
1-Chloro-1-nitropropane	2 ppm per OEL/Abandoned PELs	100 ppm
Chloropicrin	0.1 ppm	2 ppm
beta- Chloroprene	10 ppm per OEL/Abandoned PELs	300 ppm (Ca)
Chromic acid and chromates	0.1 mg/m^3 (C)	15 mg/m^3 (as Cr [VI]) (Ca)
Chromium metal (as Cr)	0.5 mg/m^3 per OEL/Abandoned PELs	250 mg/m^3
Chromium (II) and (III) compounds	0.5 mg/m^3	250 mg/m^3 (as Cr [II])25 mg/m^3 (as Cr [III])
Coal Tar Pitch Volatiles	0.2 mg/m^3	80 mg/m^3 (Ca)
Cobalt metal, dust and fume (as Co)	0.05 mg/m^3 per OEL/Abandoned PELs	20 mg/m^3
Copper dusts and mists (as Cu)	1 mg/m^3	100 mg/m^3
Copper fumes (as Cu)	0.1 mg/m^3	100 mg/m^3
Cotton dust (raw)	1 mg/m^3	100 mg/m^3
Crag herbicide	10 mg/m^3 per OEL/Abandoned PELs	500 mg/m^3
Cresol (all isomers)	5 ppm	250 ppm
Crotonaldehyde	2 ppm	50 ppm
Cumene	50 ppm	900 ppm (LEL)
Cyanides (as Cn)	5 mg/m^3	50 mg/m^3
Cyclohexane	300 ppm	1,300 ppm (LEL)
Cyclohexanol	50 ppm	400 ppm
Cyclohexanone	25 ppm per OEL/Abandoned PELs	700 ppm
Cyclohexene	300 ppm	2,000 ppm
Cyclopentadiene	75 ppm	750 ppm
2,4-D	10 mg/m^3	100 mg/m^3
DDT	1 mg/m^3	500 mg/m^3 (Ca)

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Decaborane	0.3 mg/m^3	15 mg/m^3
Demeton	0.1 mg/m^3	10 mg/m^3
Diacetone alcohol	50 ppm	1,800 ppm (LEL)
Diazomethane	0.2 ppm	2 ppm
Diborane	0.1 ppm	15 ppm
1,2-Dibromo-3-chloropropane	0.001 oppm	ND (Ca)
Dibutyl phosphate	1 ppm	30 ppm
Dibutyl phathalate	5 mg/m^3	4,000 mg/m^3
o-Dichlorobenzene	50 ppm (C)	200 ppm
p-Dichlorobenzene	75 ppm	150 ppm (Ca)
3,3-Dichlorobenzidine	Ca	ND (Ca)
Dichlorodifluoromethane	1,000 ppm	15,000 ppm
1,3-Dichloro-5,5-dimethylhydantoin	0.2 mg/m^3	5 mg/m^3
1,1-Dichloroethane	100 ppm	3,000 ppm
1,2-Dichloroethylene	200 ppm	1,000 ppm
Dichloroethyl ether	5 ppm per OEL/Abandoned PELs	100 ppm (Ca)
Dichloromonofluoromethane	10 ppm per OEL/Abandoned PELs	5,000 ppm
1,1-Dichloro-1-nitroethane	2 ppm per OEL/Abandoned PELs	25 ppm
Dichlorotetrafluoroethane	1000 ppm	15,000 ppm
Dichlorvos	1 mg/m^3	100 mg/m^3
Dieldrin	0.25 mg/m^3	50 mg/m^3 (Ca)
Diesel Fuel Marine (DFM)	350 mg/m^3	ND
Diethylamine	10 ppm per OEL/Abandoned PELs	200 ppm
2-Diethylaminoethanol	10 ppm	100 ppm
Difluorodibromomethane	100 ppm	2,000 ppm
Digycidyl ether	0.1 ppm per OEL/Abandoned PELs	10 ppm (Ca)
Diisobutyl ketone	25 ppm per OEL/Abandoned PELs	500 ppm
Diisopropylamine	5 ppm	200 ppm
Dimethyl acetamide	10 ppm	300 ppm
Dimethylamine	10 ppm	500 ppm
4-Dimethylaminoazobenzene	Ca	ND (Ca)
Dimethylaniline	5 ppm	100 ppm
Dimethyl-1,2-dibromo-2,2-dichlorethyl phosphate	3 mg/m^3	200 mg/m^3
Dimethylformamide	10 ppm	500 ppm
1,1-Dimethylhdrazine	0.5 ppm	15 ppm (Ca)
Dimethylphthalate	5 mg/m^3	2,000 mg/m^3
Dimethyl Sulfate	0.1 ppm per OEL/Abandoned PELs	7 ppm (Ca)
Dinitrobenzene (all isomers)	1 mg/m^3	50 mg/m^3
Dinitro-o-cresol	0.2 mg/m^3	5 mg/m^3
Dinitrotoluene	1.5 mg/m^3	50 mg/m^3 (Ca)
Dioxane	25 ppm per OEL/Abandoned PELs	500 ppm (Ca)
Diphenyl	0.2 ppm per OSHA PEL & OEL/ Abandoned PELs	100 mg/m^3
Dipropylene glycol methyl ether	100 ppm	600 ppm
Di-sec octyl phthalate	5 mg/m^3	5,000 mg/m^3 (Ca)
Endrin	0.1 mg/m^3	2 mg/m^3

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Epichlorohydrin	2 ppm per OEL/Abandoned PELs	75 ppm (Ca)
EPN	0.5 mg/m^3	5 mg/m^3
Ethanolamine	3 ppm	30 ppm
2-Ethoxyethanol	200 ppm	500 ppm
2-Ethoxyethyl acetate	100 ppm	500 ppm
Ethyl acetate	400 ppm	2,000 ppm (LEL)
Ethyl acrylate	5 ppm per OEL/Abandoned PELs	300 ppm (Ca)
Ethylamine	10 ppm	600 ppm
Ethyl benzene	100 ppm	800 ppm
Ethyl bromide	200 ppm	2,000 ppm
Ethyl butyl ketone	50 ppm	1,000 ppm
Ethyl chloride	1,000 ppm	3,800 ppm (LEL)
Ethylene chlorohydrin	1 ppm (C) per OEL/Abandoned PELs	7 ppm
Ethylenediamine	10 ppm	1,000 ppm
Ethylene dibromide	20 ppm/30 ppm (C) per OSHA PEL and OEL/Abandoned PELs	100 ppm
Ethylene dichloride	1 ppm per OEL/Abandoned PELs	50 (Ca)
Ethylene glycol	0.2 ppm (C) per OSHA PEL	ND
Ethyleneimine	Ca	100 ppm (Ca)
Ethylene oxide	1 ppm	800 ppm (Ca)
Ethyl ether	400 ppm	1,900 ppm (LEL)
Ethyl formate	100 ppm	1,500 ppm
Ethyl Mercaptan	0.5 ppm	500 ppm
N-Ethylmorpholine	5 ppm per OEL/Abandoned PELs	100 ppm
Ethyl Silicate	10 ppm per OEL/Abandoned PELs	700 ppm
Ferbam	10 mg/m^3 per OEL/Abandoned PELs	800 mg/m^3
Ferrovanadium dust	1 mg/m^3	500 mg/m^3
Fluorine	0.1 ppm	25 ppm
Fluorotrichloromethane	1,000 ppm	2,000 ppm
Formaldehyde	0.75 ppm	20 ppm (Ca)
Formic acid	5 ppm	30 ppm
Furfural	2 ppm per OEL/Abandoned PELs	100 ppm
Furfuryl alcohol	10 ppm per OEL/Abandoned PELs	75 ppm
Glycidol	25 ppm per OEL/Abandoned PELs	150 ppm
Graphite (natural)	2.5 mg/m^3	1,250 mg/m^3
Hafnium and compounds (Hf)	0.5 mg/m^3	50 mg/m^3
Heptachlor	0.5 mg/m^3	35 mg/m^3 (Ca)
n-Heptane	400 ppm per OEL/Abandoned PELs	750 ppm
Hexachloroethane	1 ppm	300 ppm (C)
Hexachloronaphthalene	0.2 mg/m^3	2 mg/m^3
n-Hexane	50 ppm per OEL/Abandoned PELs	1,100 ppm (LEL)
2-Hexanone	5 ppm per OEL/Abandoned PELs	1,600 ppm
Hexone	50 ppm per OEL/Abandoned PELs	500 ppm
sec-Hexyl acetate	50 ppm	500 ppm
Hydrazine	0.1 ppm per OEL/Abandoned PELs	50 ppm (Ca)

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Hydrogen bromide	3 ppm	30 ppm
Hydrogen chloride	5 ppm (C)	50 ppm
Hydrogen cyanide	10 ppm	50 ppm
Hydrogen fluoride	3 ppm	30 ppm
Hydrogen peroxide	1 ppm	75 ppm
Hydrogen selenide	0.05 ppm (as Se)	1 ppm
Hydrogen sulfide	10 ppm	100 ppm
Hydroquinone	2 mg/m^3	50 mg/m^3
Iodine	0.1 ppm (C)	2 ppm
Iron oxide dust and fume (as Fe)	10 mg/m^3	2,500 mg/m^3
Isoamyl acetate	100 ppm	1,000 ppm
Isoamyl alcohol- (primary and secondary)	100 ppm	500 ppm
Isobutyl acetate	150 ppm	1,300 ppm (LEL)
Isobutyl alcohol	50 ppm per OEL/Abandoned PELs	1,600 ppm
Isophorone	4 ppm per OEL/Abandoned PELsa	200 ppm
Isopropyl acetate	250 ppm	1,800 ppm
Isopropyl alcohol	400 ppm	2,000 ppm (LEL)
Isopropylamine	5 ppm	750 ppm
Isopropyl ether	500 ppm	1,400 ppm (LEL)
Isopropyl glycidyl	50 ppm	400 ppm
JP-5 (see NOTE 1)	350 mg/m^3	ND
JP-8 (see NOTE 1)	350 mg/m^3	ND
Ketene	0.5 ppm	5 ppm
Lead (as Pb)	0.050 mg/m^3	100 mg/m^3
Lindane	0.5 mg/m^3	50 mg/m^3
Lithium hydride	0.025 mg/m^3	0.5 mg/m^3
L.P.G.	1,000 ppm	2,000 ppm (LEL)
Magnesium oxide	10 mg/m^3 per OEL/Abandoned PELs	750 mg/m^3
Malathion	10 mg/m^3 per OEL/Abandoned PELs	250 mg/m^3
Maleic anhydride	0.25 ppm	10 mg/m^3
Manganese compounds (as Mn)	5 mg/m^3 (C)	500 mg/m^3
Mercury Vapor (Hg)	0.05 mg/m^3 per OEL/Abandoned PELs	10 mg/m^3
Mercury (organo) alkyl compounds Hg)	0.01 mg/m^3	2 mg/m^3
Mesityl oxide	15 ppm per OEL/Abandoned PELs	1,400 ppm (LEL)
Methoxychlor	10 mg/m^3 per OEL/Abandoned PELs	5,000 mg/m^3 (Ca)
Methyl acetate	200 ppm	3,100 ppm (LEL)
Methyl acetylene	1,000 ppm	1,700 ppm (LEL)
Methyl acrylate	10 ppm	250 ppm
Methyial	1,000 ppm	2,200 ppm (LEL)
Methyl alcohol	200 ppm	6000 ppm
Methylamine	10 ppm	100 ppm
Methyl (n-amyl) ketone	100 ppm	800 ppm
Methyl Bromide	5 ppm per OEL/Abandoned PELs	250 ppm (Ca)

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Methyl Cellosolve	0.1 ppm	200 ppm
Methyl Chloride	50 ppm per OEL/Abandoned PELs	2,000 ppm (Ca)
Methyl Chloroform	350 ppm	700 ppm
Methylcyclohexanol	50 ppm per OEL/Abandoned PELs	500 ppm
O-Methylcyclohexanone	100 ppm	600 ppm
Methylene bisphenyl isocyanate	0.2 mg/m^3 (C)	75 mg/m^3
Methylene chloride	25 ppm per OSHA PEL and OEL/ Abandoned PELs	2,300 ppm (Ca)
Methyl formate	100 ppm	4,500 ppm
5-Methyl-3-heptanone	25 ppm	100 ppm
Methyl hydrazine	0.2 ppm (C)	20 ppm (Ca)
Methyl iodide	2 ppm per OEL/Abandoned PELs	100 ppm (Ca)
Methyl isobutyl carbinol	25 ppm	400 ppm
Methyl isocyanate	0.02 ppm	3 ppm
Methyl mercaptan	0.5 ppm	150 ppm
Methyl methacrylate	100 ppm	1,000 ppm
Alpha-Methyl styrene	50 ppm per OEL/Abandoned PELs	700 ppm
Mica (containing less than 1% Quartz)	3 mg/m^3	1,500 mg/m^3
Molybdenum (and soluble compounds as Mo)	5 mg/m^3	1,000 mg/m^3
Molybdenum (and insoluble compounds as Mo)	10 mg/m^3 per OEL/Abandoned PELs	5,000 mg/m^3
Monomethyl aniline	0.5 ppm per OEL/Abandoned PELs	100 ppm
Morpholine	20 ppm	1,400 ppm (LEL)
Naphtha	100 ppm	1,000 ppm (LEL)
Naphthalene	10 ppm	250 ppm
Alpha-Naphthylamine	Ca	ND (Ca)
Beta-Naphthylamine	Ca	ND (Ca)
Nickel carbonyl (as Ni)	0.001 ppm	2 ppm
Nickel metal (and other compounds as Ni)	1 mg/m^3	10 mg/m^3 (as Ni) (Ca)
Nicotine	0.5 mg/m^3	5 mg/m^3
Nitric acid	2 ppm	25 ppm
Nitric oxide	25 ppm	100 ppm
p-Nitroaniline	3 mg/m^3 per OEL/Abandoned PELs	300 mg/m^3
Nitrobenzene	1 ppm	200 ppm
4-Nitrobiphenyl	Ca	ND (Ca)
P-Nitrochlorobenzene	1 mg/m^3	1,000 mg/m^3 (Ca)
Nitroethane	100 ppm	1,000 ppm
Nitrogen dioxide	1 ppm / 5 ppm (C) per OEL/Abandoned PELs	20 ppm
Nitrogen trifluoride	10 ppm	1,000 ppm
Nitroglycerine	0.2 ppm (C)	75 mg/m^3
Nitromethane	100 ppm	750 ppm
1-Nitropropane	25 ppm	1,000 ppm
2-Nitropropane	10 ppm per OEL/Abandoned PELs	100 ppm (Ca)
n-Nitrosodimethylamine	Ca	ND (Ca)

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Nitrotoluene	2 ppm per OEL/Abandoned PELs	200 ppm
Octachloronaphthalene	0.1 mg/m^3	Unknown
Octane	300 ppm per OEL/Abandoned PELs	1,000 ppm (LEL)
Oil mist (mineral)	5 mg/m^3	2,500 mg/m^3 (as Os)
Osmium tetroxide	0.002 mg/m^3	1 mg/m^3
Oxalic acid	1 mg/m^3	500 mg/m^3
Oxygen difluoride	0.05 ppm (C) per OEL/Abandoned PELs	0.5 ppm
Ozone	0.1 ppm	5 ppm
Paraquat	0.1 mg/m^3 per OEL/Abandoned PELs	1 mg/m^3
Parathion	0.1 mg/m^3	10 mg/m^3
Pentaborane	0.005 ppm	1 ppm
Pentachloronaphthalene	0.5 mg/m^3	Unknown
Pentachlorophenol	0.5 mg/m^3	2.5 mg/m^3
n-Pentane	500 ppm	1,500 ppm (LEL)
2-Pentanone	200 ppm	1,500 ppm
Perchloromethyl mercaptan	0.1 ppm	10 ppm
Perchloryl fluoride	3 ppm	100 ppm
Petroleum distillates	400 ppm per OEL/Abandoned PELs	1,100 ppm (LEL)
Phenol	5 ppm	250 ppm
p-Phenylene diamine	0.1 mg/m^3	25 mg/m^3
Phenyl ether (vapor)	1 ppm	100 ppm
Phenyl ether-biphenyl mixture (vapor)	1 ppm	10 ppm
Phenyl glycidyl ether	1 ppm per OEL/Abandoned PELs	100 ppm (Ca)
Phenylhydrazine	5 ppm	15 ppm (Ca)
Phosdrin	0.1 mg/m^3	4 ppm
Phosgene	0.1 ppm	2 ppm
Phosphine	0.3 ppm	50 ppm
Phosphoric acid	1 mg/m^3	1,000 mg/m^3
Phosphorus	0.1 mg/m^3 per OEL/Abandoned PELs	200 mg/m^3
Phosphorus pentasulfide	1 mg/m^3	250 mg/m^3
Phosphorus trichloride	0.2 ppm per OEL/Abandoned PELs	25 ppm
Phosphorus (yellow)	0.1 mg/m^3	5 mg/m^3
Phthalic anhydride	1 ppm per OEL/Abandoned PELs	60 mg/m^3
Picric acid	0.1 mg/m^3	75 mg/m^3
Pindone	0.1 mg/m^3	100 mg/m^3
Platinum (soluble salts as Pt)	0.002 mg/m^3	ND
Portland cement	10 mg/m^3 per OEL/Abandoned PELs	5,000 mg/m^3
Propane	1,000 ppm	2,100 ppm (LEL)
Beta-Propiolactone	Ca	ND (Ca)
n-Propyl acetate	200 ppm	1,700 ppm
n-Propyl alcohol	200 ppm	800 ppm
n-Propyl nitrate	25 ppm	500 ppm
Propylene dichloride	75 ppm	400 ppm (Ca)

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Propylene imine	2 ppm	100 ppm (Ca)
Propylene oxide	20 ppm per OEL/Abandoned PELs	400 ppm (Ca)
Pyrethrum	5 mg/m^3	5,000 mg/m^3
Pyridine	5 ppm	1,000 ppm
Quinone	0.1 ppm	100 mg/m^3
Rhodium (metal fume and insoluble compounds as Rh)	0.1 mg/m^3	100 mg/m^3
Rhodium (soluble compounds as Rh)	0.001 mg/m^3	2 mg/m^3
Ronnel	10 mg/m^3	300 mg/m^3
Rotenone	5 mg/m^3	2,500 mg/m^3
Selenium compounds (as Se)	0.2 mg/m^3	1 mg/m^3
Selenium hexafluoride (as Se)	0.05 ppm	2 ppm
Silica amorphous	6 mg/m^3	3,000 mg/m^3
Silica crystalline	0.05 mg/m^3	ND (Ca)
Silver (metal dust and soluble compounds as Ag)	0.01 mg/m^3	10 mg/m^3
Soapstone (containing less than 1% quartz)	6 mg/m^3	3,000 mg/m^3
Sodium fluoroacetate	0.05 mg/m^3	2.5 mg/m^3
Sodium hydroxide	2 mg/m^3 (C) per OEL/Abandoned PELs	10 mg/m^3
Stibine	0.1 ppm	5 ppm
Stoddard solvent	100 ppm per OEL/Abandoned PELs	20,000 mg/m^3
Strychnine	0.15 mg/m^3	3 mg/m^3
Styrene	50 ppm per OEL/Abandoned PELs	700 ppm
Sulfur dioxide	2 ppm per OEL/Abandoned PELs	100 ppm
Sulfuric acid	1 mg/m^3	15 mg/m^3
Sulfur monochloride	1 ppm (C)	5 ppm
Sulfur pentafluoride	0.01 ppm (C) per OEL/Abandoned PELs	1 ppm
Sulfuryl fluoride	5 ppm	200 ppm
2,4,5-T	10 mg/m^3	250 mg/m^3
Talc	2 mg/m^3	1,000 mg/m^3
Tantalum	5 mg/m^3	2,500 mg/m^3 (as Ta)
TEDP	0.2 mg/m^3	10 mg/m^3
Tellurium and compounds (as Te)	0.1 mg/m^3	25 mg/m^3
Tellurium hexafluoride	0.02 ppm	1 ppm
TEPP	0.05 mg/m^3	5 mg/m^3
Terphenyls	0.5 ppm (C) per OEL/Abandoned PELs	500 mg/m^3
1,1,2,2-Tetrachloro- 1,2 - difluoroethane	500 ppm	2,000 ppm
1,1,1,2-Tetrachloro- 2,2 - difluoroethane	500 ppm	2,000 ppm
1,1,2,2-Tetrachloroethane	1 ppm per OEL/Abandoned PELs	100 ppm (Ca)
Tetrachloroethylene	100 ppm	150 ppm (Ca)
Tetrachloronaphthalene	2 mg/m^3	Unknown
Tetraethyl lead (as Pb)	0.075 mg/m^3 per OSHA PEL and OEL/Abandoned PELs	40 mg/m^3

Exposure Limits - Continued

Chemical Name	PEL	IDLH
Tetrahydrofuran	200 ppm	2,000 ppm
Tetramethyl lead (as Pb)	0.075 mg/m^3 per OSHA PEL and OEL/Abandoned PELs	40 mg/m^3
Tetramethyl succinonitrile	0.5 ppm	5 ppm
Tetranitromethane	1 ppm	4 ppm
Tetryl	1.5 mg/m^3	750 mg/m^3
Thallium (soluble compounds as Ti)	0.1 mg/m^3	15 mg/m^3
Thiram	5 mg/m^3	100 mg/m^3
Tin (inorganic compounds except Oxides as Sn)	2 mg/m^3	100 mg/m^3
Tin (organic compounds as Sn)	0.1 mg/m^3 per OSHA PEL and OEL/Abandoned PELs	25 mg/m^3
Titanium dioxide	10 mg/m^3 per OEL/Abandoned PELs	5,000 mg/m^3 (Ca)
Toluene	100 ppm per OEL/Abandoned PELs	500 ppm
Toluene-2,4-diisocyanate	0.005 ppm per OEL/Abandoned PELs	2.5 ppm (Ca)
o-Toluidine	5 ppm	50 ppm (Ca)
Tributyl phosphate	0.2 ppm per OEL/Abandoned PELs	30 ppm
1,1,2-Trichloroethane	10 ppm	100 ppm (Ca)
Trichloroethylene	50 ppm per OEL/Abandoned PELs	1,000 ppm (Ca)
Trichloronaphthalene	5 mg/m^3	Unknown
1,2,3-Trichloropropane	10 ppm per OEL/Abandoned PELs	100 ppm (Ca)
1,1,2-Trichloro- 1,2,2- trifluoroethane	1,000 ppm	2,000 ppm
Triethylamine	10 ppm per OEL/Abandoned PELs	200 ppm
Trifluorobromomethane	1,000 ppm	40,000 ppm
2,4,6-Trinitrotoluene	1.5 mg/m^3	500 mg/m^3
Triorthocresyl phosphate	0.1 mg/m^3	40 mg/m^3
Triphenyl phosphate	3 mg/m^3	1,000 mg/m^3
Turpentine	100 ppm	800 ppm
Uranium (insoluble compounds as U)	0.2 mg/m^3	10 mg/m^3 (Ca)
Uranium (soluble compounds as U)	0.05 mg/m^3 per OSHA PEL and OEL/Abandoned PELs	10 mg/m^3 (Ca)
Vanadium Pentoxide (respirable dust as V_2O_5)	0.05 mg/m^3 per OEL/Abandoned PELs	35 mg/m^3 (as V)
Vanadium Pentoxide (respirable fume as V_2O_5)	0.05 mg/m^3 per OEL/Abandoned PELs	35 mg/m^3
Vinyl chloride	1 ppm / 5 ppm (C)	ND (Ca)
Vinyl Toluene	100 ppm	400 ppm
Warfarin	0.1 mg/m^3	100 mg/m^3
Xylenes (o-,m-,p-isomers)	100 ppm	900 ppm
Xylidine	2 ppm per OEL/Abandoned PELs	50 ppm
Yttrium (compounds as Y)	1 mg/m^3	500 mg/m^3 (as Y)
Zinc chloride fume	1 mg/m^3	50 mg/m^3
Zinc oxide fume	5 mg/m^3	500 mg/m^3
Zirconium (compounds as Zr)	5 mg/m^3	50 mg/m^3
NOTE 1 - The PEL is based on the findings of the Navy Occupational Safety and Health (NAVOSH) Standardsd Update Board.		

APPENDIX H

GAS FREE ENGINEERING EQUIPMENT REFERENCE

The appendix was prepared to assist GFEP as a quick reference for possible gas free equipment and protective clothing usage. References are available for equipment and clothing stock information such as Affloat Supply guide Section 1 (http://www.dlis.dla.mil/navy/asg_guide/asp).

Gas Free Engineering Equipment is divided into the following areas:

1. Eye and Face Protection
2. Hand Protection
3. Head Protection
4. Hearing Protection
5. Respiratory Protective Equipment
6. Safety Shoes and Boots
7. Body Protection/Coveralls
8. Miscellaneous Accessories

For more detailed and comprehensive information on equipment items and stock information to GFE, refer to NAVSEA Damage Control and Personnel Protection webpage, (http://www.dcfpnavymil.org).

APPENDIX I

APPROVED GFE SIGNAGE

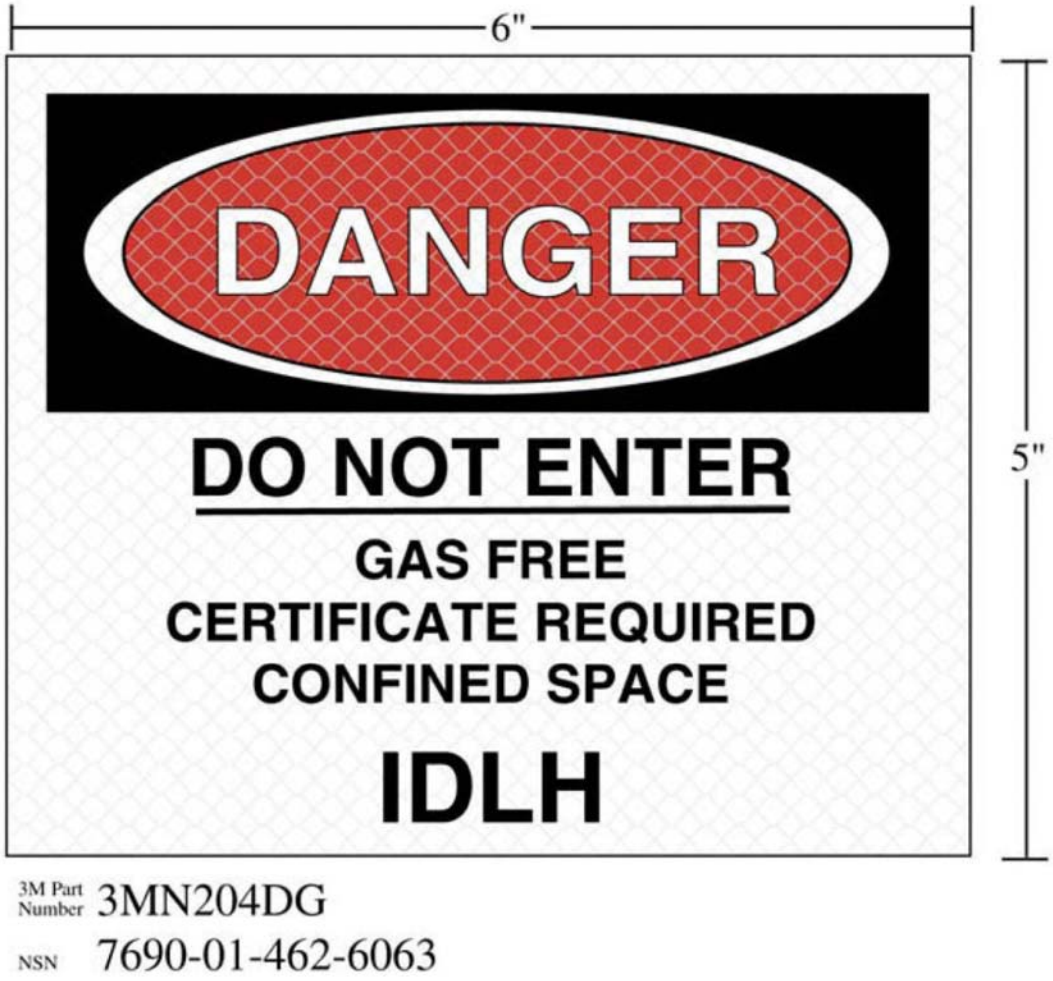


Figure 074-I-1. Shipboard Compartment Identified IDLH by GFE

Figure 074-I-2. Shipboard Compartment Requires GFE Services

Figure 074-I-3. Shipboard Compartment Cleared by GFE

APPENDIX J

METRIC CONVERSION CHART

Table 074-J-1. METRIC CONVERSION CHART

Celsius-Fahrenheit Conversion							
°C	**°F**	**°C**	**°F**	**°C**	**°F**	**°C**	**°F**
-75	-103	40	104	155	311	537.8	1,000
-73.3	-100	43.3	110	160	320	550	1,022
-70	-94	45	113	165	329	593.3	1,100
-67.8	-90	48.9	120	165.6	330	600	1,112
-65	-85	50	122	170	338	648.9	1,200
-62.2	-80	54.4	130	171.1	340	650	1,202
-60	-76	55	131	175	347	700	1,292
-56.7	-70	60	140	176.7	350	704.4	1,300
-55	-67	65	149	180	356	750	1,382
-51.1	-60	65.6	150	182.2	360	760	1,400
-50	-58	70	158	185	365	800	1,472
-45.6	-50	71.1	160	187.8	370	815.6	1,500
-45	-49	75	167	190	374	850	1,562
-40	-40	76.7	170	193.3	380	871.1	1,600
-35	-31	80	176	195	383	900	1,652
-34.4	-30	82.2	180	198.9	390	926.7	1,700
-30	-22	85	185	200	392	950	1,742
-28.9	-20	87.8	190	204.4	400	982.2	1,800
-25	-13	90	194	225	437	1,000	1,832
-23.3	-10	93.3	200	232.2	450	1,037.8	1,900
-20	-4	95	203	250	482	1,050	1,922
-17.8	0	98.9	210	260	500	1,093.3	2,000
-15	5	100	212	275	527	1,100	2,012
-12.2	10	104.4	220	287.8	550	1,148.9	2,100
-10	14	105	221	300	572	1,150	2,102
-6.7	20	110	230	315.6	600	1,200	2,192
-5	23	115	239	325	617	1,204.4	2,200
-1.1	30	115.6	240	343.3	650	1,250	2,282
0	32	120	248	350	662	1,260	2,300
4.4	40	121.1	250	371.1	700	1,300	2,372
5	41	125	257	375	707	1,315.6	2,400
10	50	126.7	260	398.9	750	1,350	2,462
15	59	130	266	400	752	1,371.1	2,500
15.6	60	132.2	270	425	797	1,400	2,552
20	68	135	275	426.7	800	1,426.7	2,600
21.1	70	137.8	280	450	842	1,500	2,732
25	77	140	284	454.4	850	1,537.8	2,800
26.7	80	143.3	290	475	887	1,550	2,822
30	86	145	293	482.2	900	1,593.3	2,900
32.2	90	148.9	300	500	932	1,600	2,912
35	95	150	302	510	950	1,648.9	3,000

Table 074-J-1. METRIC CONVERSION CHART - Continued

Celsius-Fahrenheit Conversion							
°C	**°F**	**°C**	**°F**	**°C**	**°F**	**°C**	**°F**
37.8	100	154.4	310	525	977	1,650	3,002

APPENDIX K

PORTABLE GAS FREE INSTRUMENT CERTIFICATION

074-K.1 INTRODUCTION

The Occupational Safety and Health Administration (OSHA) determines certification standards for instruments which measure the amount of toxic gas to which a worker may be exposed without causing serious health problems. OSHA standards provide guidance to the manufacturer on how the instrument readings are set and whether the instrument reads in parts per million (ppm) or percent by volume. OHSA does not, however, certify individual instruments.

a. Only gas free equipment which is tested by a nationally recognized testing laboratory (NRTL) meets OSHA standards and thereby receives OSHA approval. These laboratories test portable equipment for ″intrinsic safety.″ An intrinsically safe instrument is one that will not cause an explosion, even if used in an explosive atmosphere, either by causing a spark or by giving off excessive heat which could serve as a source of ignition.

b. The gas free instruments used in the Navy shall be certified by an NRTL for Class I, Division I, Groups A, B, C and D (the classes, divisions and groups are listed in the National Fire Protection Association publication, NFPA No. 70, Chapter 5, which is the National Electrical Code). Locations are classified according to the properties of the flammable gases or vapors, which may be present, and the likelihood that a flammable or combustible concentration or quantity is present.

074-K.2 CLASS I LOCATIONS

Locations in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures are classified as Class I.

074-K.3 CLASS I, DIVISION 1

Locations in which:

a. Ignitable concentrations of flammable gases or vapors can exist under normal operating conditions; or

b. Ignitable concentration of such gases or vapors may exist frequently because of repair or maintenance operations of leakage; or

c. Breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors.

074-K.4 GROUPS A - D

a. Group A is an atmosphere containing acetylene.

b. Group B is an atmosphere containing hydrogen, fuel and combustible process gases containing more than 30 percent hydrogen by volume, or gases or vapors of equivalent hazard such as:
   1. Butadiene
   2. Ethylene oxide

3. Propylene oxide
4. Acrolein

c. Group C is an atmosphere containing:
   1. Ethyl ether
   2. Ethylene
   3. Gases or vapors of equivalent hazard.

d. Group D is an atmosphere containing:
   1. Acetone
   2. Ammonia
   3. Benzene
   4. Butane
   5. Cyclopropane
   6. Ethanol
   7. Gasoline
   8. Hexane
   9. Methane
   10. Methanol
   11. Naphtha
   12. Natural gas
   13. Propane
   14. Gases or vapors of equivalent hazard.

e. The Approval and Certification Center, Mine Safety and Health Administration (MSHA) has indicated the following concerning the relationship between safety approvals and Group D atmospheres cited above:
   1. MSHA intrinsic safety approvals are strictly for underground gassy mines and are not considered safe in Class I, Division I, Group D locations.
   2. MSHA-approved equipment is tested for use in areas containing methane (or natural gas) and coal dust.
   3. Although methane is a Group D gas, it is not the most easily ignited gas found in Group D. Therefore, equipment which qualifies for use in the presence of methane is not necessarily safe for use in the presence of all Group D gases.
   4. Similarly, equipment which is safe for use where coal dust is present is not safe for use with other types of dust which may more easily conduct electricity, which may have a lower layer ignition temperature or which may have a lower dust cloud minimum ignition energy.

f. Additional classes, divisions and groups which deal with combustible dusts are listed in the National Electrical Code.

074-K.5 NRTLs CERTIFIED BY OSHA

a. The following two laboratories have been temporarily recognized through July 13, 1993, without any product category specifications:
   1. Underwriters Laboratories, Inc. (UL)

2. Factory Mutual Research Corporation (FMRC).

b. Four laboratories have been recognized by OSHA for certifying certain products or categories of products by complying with the procedures as outlined in Appendix A of the Code of Federal Regulations, CFR 29 1910.7:

1. MET Electrical Testing Company, Inc. (MET)
2. Dash, Straus and Goodhue, Inc. (DSG)
3. ETL Testing Laboratories, Inc. (ETL)
4. American Gas Association Laboratories (AGA).

074-K.6 GAS FREE INSTRUMENTS

Underwriters Laboratories, Inc. and Factory Mutual Research Corporation affix their respective trademarks to all instruments they approve.

a. UL trademarks include those shown in Figure 074-K-1.

b. Factory Mutual trademarks include those shown in Figure 074-K-2.

074-K.7 AUTHORIZED GAS FREE INSTRUMENTS

074-K.7.1 For more detailed and comprehensive information on authorized gas free instrument, refer to NAVSEA Damage Control and Personnel Protection webpage, (http://www.dcfpnavymil.org), for a list of authorized gas free instruments currently in the supply system.

074-K.8 PARTS MANUFACTURERS

074-K.8.1 A list of gas free instrument manufacturers, from whom spare parts and accessories can be obtained on NAVSEA Damage Control and Personnel Protection webpage, (http://www.dcfpnavymil.org).

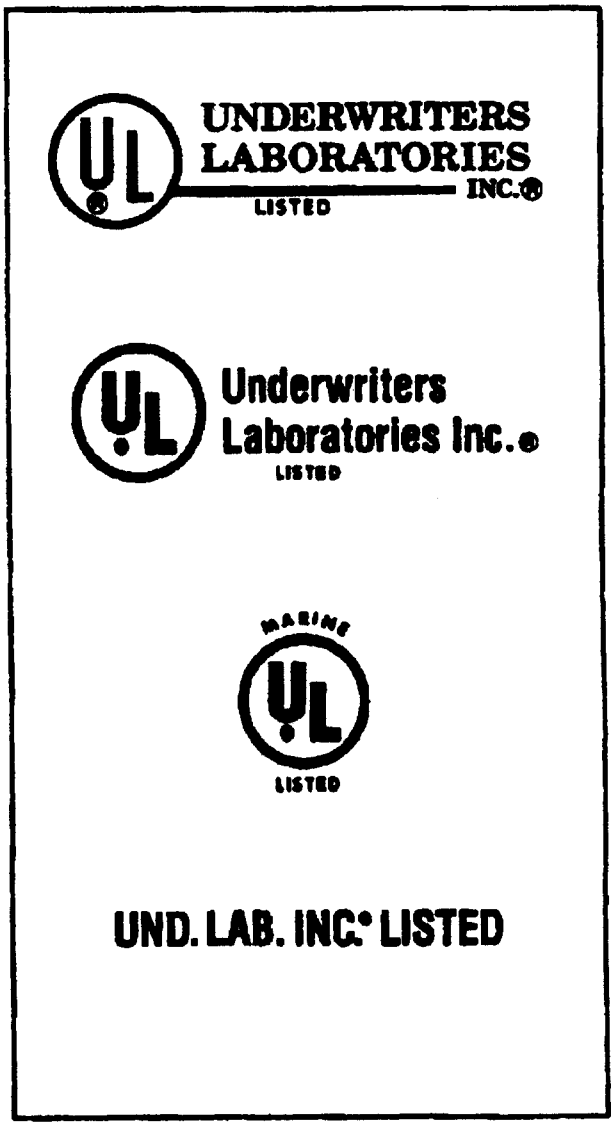


Figure 074-K-1. UL Trademarks

Figure 074-K-2. Factory Mutual Trademarks

APPENDIX L

CHEMICAL DETECTION TUBES

074-L.1 PURPOSE

The chemical detector tube system is one of several testing devices available to the GFE for monitoring toxic gases and vapors. In order to check for contaminants, an air sample is drawn through the tube with a hand pump. If a contaminant is present, it will react with the chemical reagent in the tube and change color. The color is then evaluated to determine the contaminant's level of concentration in the air. Detector tubes are inexpensive, portable and easy to use. The tests produce quick results, often within 60 seconds, but gauging the results can be difficult and requires practice. In the hands of an experienced GFE, however, the detector tube system is a valuable tool in monitoring the safety of the atmosphere in the workplace.

074-L.2 SYSTEM COMPONENTS

Chemical detector tube systems consist of a detector tube, a pump, calibrated scales and color standards, as described below.

074-L.2.1 DETECTOR TUBE. The detector tube is a sealed glass cylinder (see Figure 074-L-1).

a. As gas and vapor are pulled through some detector tubes, it is necessary to initially remove agents that would interfere with the test. The removal of unwanted gaseous chemicals is accomplished with a precleaning filter. Most precleaning layers consist of a drying agent designed to remove moisture where humidity is a problem.

b. After removal of potential interfering agents, the indicator layer of the tube reacts with the chemical under investigation. The reaction causes a discoloration that is proportional to the amount of reactive agent. Generally, it is possible to indicate the concentration of this substance to a length of the colored band. When a length of stain indication is not practical, the alternative is a detector tube with the concentration related to the color density of the stain. Tests that evaluate the color intensity are more subjective because of lighting conditions and color perception by different personnel. Whereas, tests that evaluate the length of the color stain are more accurate and consequently preferable.

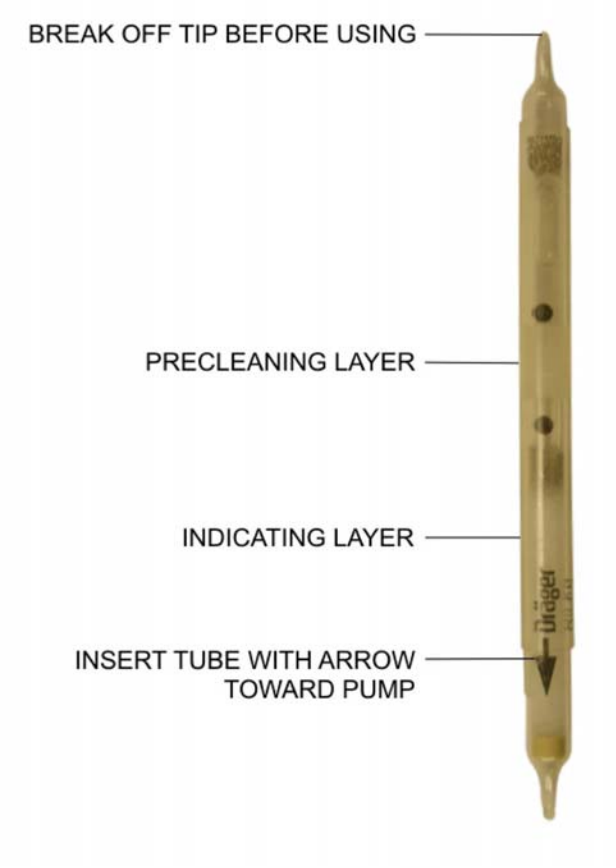


Figure 074-L-1. Chemical Detector Tube

c. Many types of detector tubes use reagents impregnated in the indicator layer which are unstable and must be mixed just prior to use of the tube. By placing reagent ampoules inside the detector tube and breaking the ampoule just prior to use, the chemical instability of such reagents is prevented. With this type of detector tube, shrink wrap tubing is placed around the section of the detector tube containing the ampoule. Therefore, when the glass detector tube and ampoule are broken the detector tube still remains intact.

d. The length or density of the color produced is directly related to the concentration of the chemical. Tests that evaluate color density are more subjective to error because they depend on light conditions which may fluctuate and vary according to the perception of the viewer. Tests that evaluate the length of the colored stain are more accurate and consequently preferable.

074-L.2.2 PUMP. You may use either a bellows or a piston pump. The manufacturer of the bellows pump should be compatible with detector tube with which it is used. Bellows pumps simultaneously draw in and measure the gas volume. They are designed for maximum simplicity and accuracy and can easily be operated with one hand. The time cycle of strokes depends on the flow resistance of the tube used. A stroke counter is included on the Accuro bellows pump. Each tube pack contains data indicating the required number of pump strokes. Most pumps move 100 ml of air sample per stroke. Some piston-type pumps, however, can be set to move less than 100 ml per stroke.

074-L.2.3 CALIBRATED SCALES AND COLOR STANDARDS

a. Detector tubes are calibrated for specific temperature ranges. Unless a relatively large amount of sample air is tested, or the air temperature is high, tube temperature usually does not affect the results. The temperature ranges for analyzing most atmospheric chemical levels generally range from 32°F to 125°F.

b. Detector tubes are calibrated for normal atmospheric pressure, about 50 percent humidity at a specific flow rate. In some systems an aperature in the pump controls the air flow rate.

c. When contact time between the contaminant and the chemical reagent is different from the calibrated contact time, the test results will be misleading. Use detector tubes in the field as close to calibration conditions as possible, paying special attention to the flow rate. Never interchange pumps and tubes from different manufacturers because flow characteristics differ from one brand to the next.

d. Certified detector tubes are accurate to ± 35 percent at 1/2 the TLV. This means that they are best used to establish either that the contaminant level is high and poses a serious problem or that the level is low and poses no problem. You should not, however, expect extremely precise measurements of the contaminant level.

074-L.2.4 LONG-TERM DETECTOR TUBE. Detector tubes which can be used over an eight-hour period for a time-weighted average (TWA) are available. These tubes are carried in a special holder clamped to the worker near his face. Air is drawn through the tube with a low volume pump (i.e., 10 to 20 ml per minute).

074-L.3 THE TESTING PROCESS

Possessing a knowledge of operations, materials used and the products, by-products and wastes produced will greatly assist in performing and interpreting the tests. It may be helpful to study the chemical reaction and color change process by preparing gas or vapor mixtures as outlined in the laboratory section of the manufacturer's manual.

a. Use tubes only within their specified temperature range and recommended detection level. For example, a tube set to measure in the 100 - 1000 ppm range would not be suitable for measuring at a 1-ppm level. Perform the procedures for conducting tests using chemical detector tubes:
   1. Break off the ends of the sealed tube; these ends should have relatively large openings.
   2. For piston pumps, line up plunger and cylinder according to the index marks on the pump. The plunger should lock easily into a 100 ml position. The pump should not leak.
   3. For bellows pumps, insert the opened tube into the pump head so that the arrow points toward the pump. The tube must fit tightly in the pump head stopper so that no extra air can be drawn in.
   4. If air flow must move only in one direction, hold the tube in the pump according to the directional marking on the tube (usually an arrow or a dot).
   5. Draw an air sample through the tube, pulling it first through the forward layer then the silica gel layer; otherwise, the test will be inaccurate.
   6. Evaluate test results. If a contaminant is present the color will change; if the color does not change, the contaminant's concentration level is below the tube's capacity to sense it. Results can be evaluated in one of several ways:
      (a). Measuring the new color's length in millimeters (mm), then converting this measurement to the level of concentration it represents.
      (b). Reading the concentration level directly from a scale imprinted on the tube.
      (c). Comparing the density of the new color with a standard color chart.

b. Reach remote test areas with a sampling line, always placing the sampling line between the tube and the pump. Do not draw air through the sampling line first because an appreciable amount of gas vapor on the line's wall could be lost.

c. Do not reuse tubes. In addition to extra moisture, other contaminants introduced into a tube could affect the color changing reagent and the silica gel activity and consequently the test results.

d. Refer to Section 074-L.5 for tube disposal procedure. Do not dispose of in an ordinary trash receptable. ▌

074-L.4 CARE AND MAINTENANCE OF DETECTOR TUBE SYSTEMS

Detector tubes are adversely affected by heat, light and age; therefore, store detector tubes in a cool area away from light, preferably in a refrigerator. Refrigeration will extend the tubes' shelf-life. Do not carry tubes where they may be exposed to high temperature. When making a test, remove only enough tubes from storage to complete that test. Tubes are dated and should not be used beyond the expiration date. Maintenance and care of detector tubes requires the following procedures:

1. Check the detector tube system on a regular basis for proper operation and response. Check the tubes for uniformity of structure, particle distribution, pack and color. Do not use tubes with any sign of discoloration.
2. Check pumps for proper operation as outlined in the manufacturer's instructions. Pumps wear, corrode, clog and are damaged by use, so also check them regularly for leaks, flow rate and volume delivery. Remove, examine and clean screens and orifices. Replace corroded or damaged orifices. If pumps require periodic greasing, use silicon grease rather than petroleum grease, which can attack the Teflon ″O″ rings.
3. Check to see that bellows pumps open freely. Arrestor chains should not be loose, stretched or kinked. Make sure that sealing screws are tight.
4. Prior to sampling, and when replacing parts, ensure the bellows pump is operating properly by administering the following tests:
   a The Rapid Opening Time Test. The bellows pump is first completely compressed then released with no tube inserted. The pump should open with no hesitation. If this is not the case, check the rubber bung, filter sieve and pump head for restrictions such as broken glass or corrosion of the filter sieve. Figure 074-L-2 illustrates the rapid opening time test.
   b The Leak Test. Used to determine if the pump is sufficiently air tight to draw a proper volume with each pump stroke, this test is illustrated in Figure 074-L-3. Once an unopened tube is inserted into the bellows pump (shown in Step One), the open pump is completely compressed (illustrated in Step Two). The Accuro pump is sufficiently airtight if it remains compressed after 15 minutes. The older style bellows pump must remain compressed after 30 minutes or if the limit chain is not taut.

074-L.5 PROPER DISPOSAL OF DETECTOR TUBES

Proper disposal of used or expired tubes is as follows:

a. Expired detector tubes must be identified, quantified and recorded on local authorized chain of custody forms by chemical name and stock number. The expired tubes are packaged for safe transportation and sent to the Defense Reutilization Marketing Office (DRMO) for disposal. Retain one copy of the chain of custody forms with signatures from DRMO.

b. Used tubes must be identified, quantified, and recorded on local authorized chain of custody forms by chemical name, stock number and also a description concerning the atmosphere where each tube was employed. The purpose for documenting how each tube was used will determine the proper disposal procedure, i.e., minimize disposal costs. The expired tubes are packaged for safe transportation and sent to the Public Works Center (PWC) for disposal. Retain one copy of the chain of custody forms with signatures from PWC.

NOTE

The above procedures may vary from one disposal agent to another depending on the terms and conditions imposed locally by their permits. Gas free personnel

are cautioned to confirm the procedures applicable in their local homeports or ports-of-call for disposal of used/expired tubes.

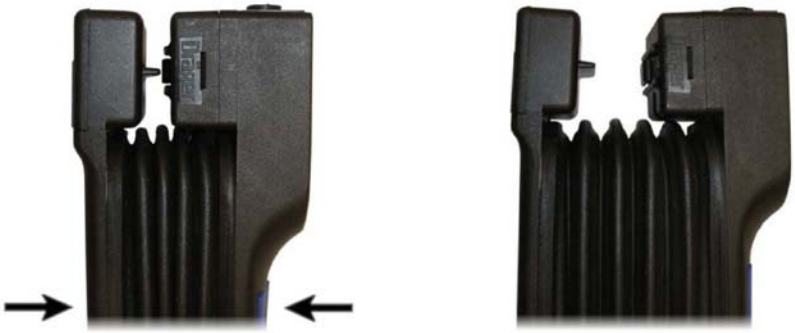


Figure 074-L-2. Rapid Opening Time Test

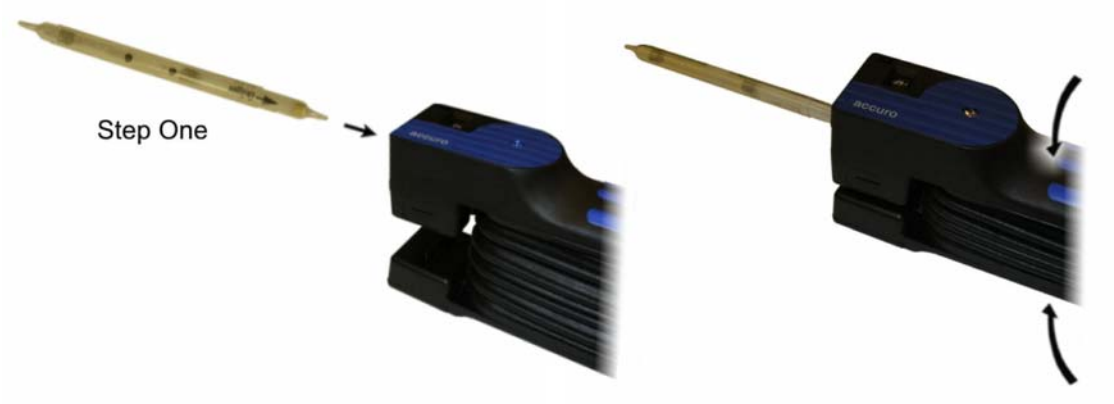


Figure 074-L-3. 30 Minute Leak Test

Table 074-L-1. Toxic Vapor Detection Tubes

Detector Tubes	Range of Measurement	No. of Strokes	National Stock Numbers	Manufacturer Order Number
Acetone 100/b*	100 to 12,000 ppm	10	1H 6665-01-010-7958*	CH22901
Ammonia 5/a*	5 to 70 ppm	10	1H 6665-01-010-7974*	CH20501
Arsine 0.05/a	0.05 to 3 ppm 1 to 60 ppm	20 1	1H 6665-00-769-0942	CH25001
Benzene 0.05*	15 to 420 ppm 0.05 to 1.4mg/L	20 to 2	1H 6665-00-769-0943*	8101741
Carbon dioxide 0. 1%/a*	0.1 to 1.2vol% 0.5 to 6 vol%	5 1	1H 6665-00-769-0945*	CH23501
Carbon disulfide 0.04	3 to 95 ppm 0.01 to 0.3 mg/L	15 to l	1H 6665-00-769-0946	8101891

Table 074-L-1. Toxic Vapor Detection Tubes - Continued

Detector Tubes	Range of Measurement	No. of Strokes	National Stock Numbers	Manufacturer Order Number
Carbon monoxide 10/b*	10 to 300 ppm 100 to 3,000 ppm	10 1	1H 6665-00-769-0949*	CH20601
Chlorine 0.2/a*	0.2 to 3 ppm 2 to 30 ppm	10 1	1H 6665-00-769-0951*	CH24301
Ethylene oxide 25/a	25 to 500 ppm	30	1H 6665-01-102-9485*	6728241
Formaldehyde 0.002	2 to 40 ppm .002 to 0.05 mg/L	5	1H 6665-00-769-0952	CH26401
Hydrazine 0.25/a*	0.25 to 3 ppm	10	1H 6665-00-140-0886*	CH31801
Hydrocarbons 0.1 %/b	0.l to l.3vol%		1H 6665-00-769-0954	CH26101
Hydrocarbon 2	2 to 23 mg/L		1H 6665-01-384-1508	CH25401
Hydrocarbon petroleum	500 to 2,500 ppm		1H 6665-12-193-2113	6730201
Hydrochloric acid*	1 to 10 ppm 2 to 20 ppm	10 5	1H 6665-01-010-7959*	CH29501
Hydrocyanic acid 2/a	2 to 30 ppm 10 to 150 ppm	5 1	1H 6665-00-769-0959	CH25701
Hydrogen fluoride 1.5*	1.5 to 15 ppm	20	1H 6665-01-010-7960*	CH30301
Hydrogen sulfide 1/c*	1 to 20 ppm 10 to 200 ppm	10 1	1H 6665-01-010-7961*	8101831
Nitrogen dioxide 0.5/c	0.5 to 10 ppm 5 to 25 ppm	5 2	6665-00-488-9467	CH30001
Ozone 0.05/b*	0.05 to 0.7 ppm	10	6630-12-307-3822	6733181
Phosgene 0.05/a*	0.04 to 1.5 ppm	26 to l	1H 6665-01-010-7965*	8101521
Sulphur dioxide 1/a*	1 to 25 ppm	10	1H 6665-01-010-7966*	CH31701
Toluene 5/a*	5 to 400 ppm	5	1H 6665-01-073-6527*	8101661
Trichloroethane 50/d*	50 to 600 ppm	2	1H 6665-01-010-7962*	CH21101
Trichloroethylene 2/a	2 to 50 ppm 20 to 200 ppm	5 3	1H 6665-01-344-1159	6728541
Trichloroethylene 10/a*	10 to 500 ppm	5	1H6665-01-010-7968*	CH24401
Triethylamine 5/a	5 to 60 ppm	5	1H 6665-01-010-7967	6718401
Vinyl chloride 1/a	1 to 10 ppm 5 to 50 ppm	20 5	6665-01-395-5213	8101721

APPENDIX M

HOISTING EQUIPMENT - RESCUE DAVIT SYSTEM

074-M.1 OVERVIEW.

The Rescue Davit System is a modular system of components for use by large decks to provide rescue-lifting capability to remove injured or exhausted firefighters or GFE personnel from the bottom of escape trunks or other confined spaces. The system consists of commercial-off-the-shelf equipment that attaches to an anchorage in the overhead area of the escape trunk (pole hoist) or a standalone tripod. The winch is operated by a supplied cordless power hammer drill and also a crank arm for emergency use or when drill is unavailable.

074-M.2 DESCRIPTION.

The system consists of the following assemblies:

- Winch Assembly
- Tripod Assembly
- Pole Hoist Assembly
- Cordless Power Hammer Drill with Charger

074-M.2.1 WINCH ASSEMBLY. The winch assembly is designed to extend and retract a cable from a drum for attaching to a person during afloat gas-free or confined space rescue missions. It is used with a Navy-approved body harness with single point attachment. The winch assembly contains a redundant braking system to hold the cable in any position. The redundant braking system is designed with an internal ratchet mechanism that engages the brake when either drive connection is turned. If primary brake system fails an inertial brake system will engage. As the cable is freewheeling, the speed increases and the inertial brake engages to stop the cable. No more than 3 feet of cable deploys before the inertial brake engages.

The winch assembly may be operated manually using a crank arm or using a power drill (see Figure 074-M-1) to extend or retract the cable. The crank arm attaches to the FAST (4:1) drive connection for manual operation. A power drive overload clutch can be attached to the SLOW (9:1) drive connection to use the battery-powered drill. The assembly includes a lightweight anodized aluminum bracket to attach it to either the pole hoist or the tripod.

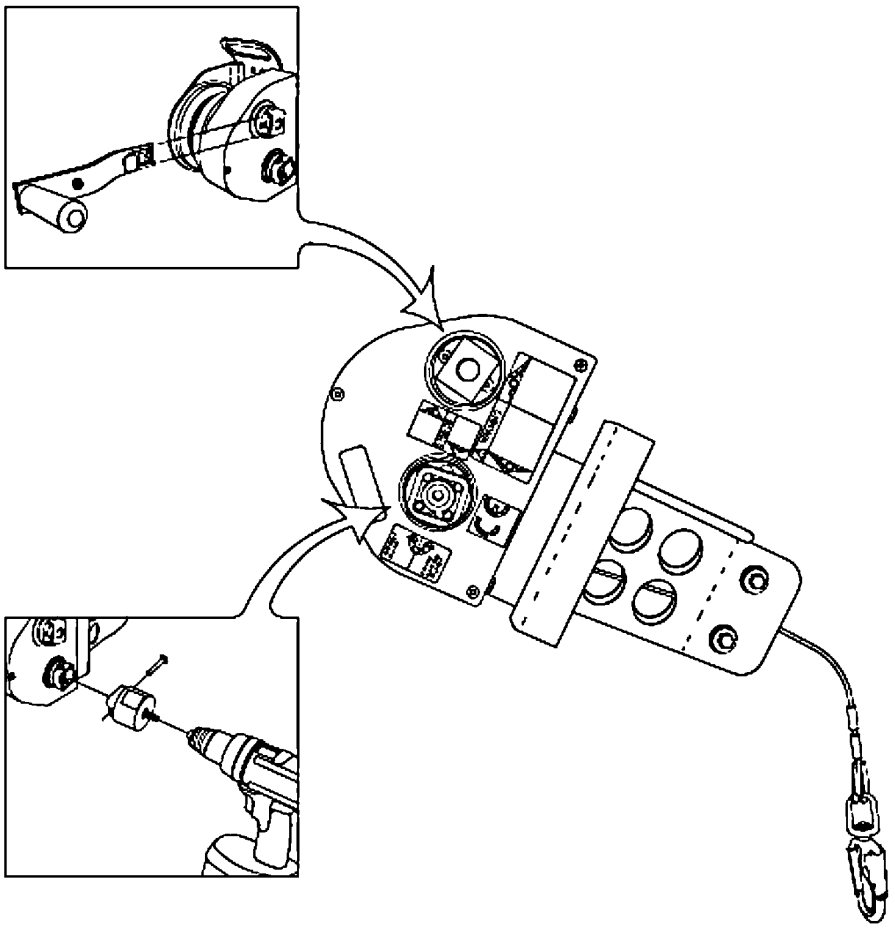


Figure 074-M-1. Winch Assembly with Crank Arm or Power Drill with Power Drive Overload Clutch

The braided stainless steel cable on the winch assembly is 100 feet long and contains a red marker 10 feet from the end of the cable to warn the operator not to extend more cable. Extending the cable past this red marker could result in freewheeling.

074-M.2.2 POLE HOIST. The pole hoist is made of lightweight anodized aluminum and is designed for usein entry/retrieval operations where an overhead anchorage point such as a pad eye or I-beam is present. The pole hoist uses steel carabiners and anchor tie-offs made of webbed nylon and polyester blend with steel connector rings to connect to the overhead anchorage point and the pole hoist (see Figure 074-M-2). If anI-beam is present, the supplied steel I-beam clamp secures to the I-beam providing the anchorage point for the anchor tie-off and carabiner. The pole hoist is collapsible for portability and stowage and disassembled with attached zinc-plated steel quick-release pins.

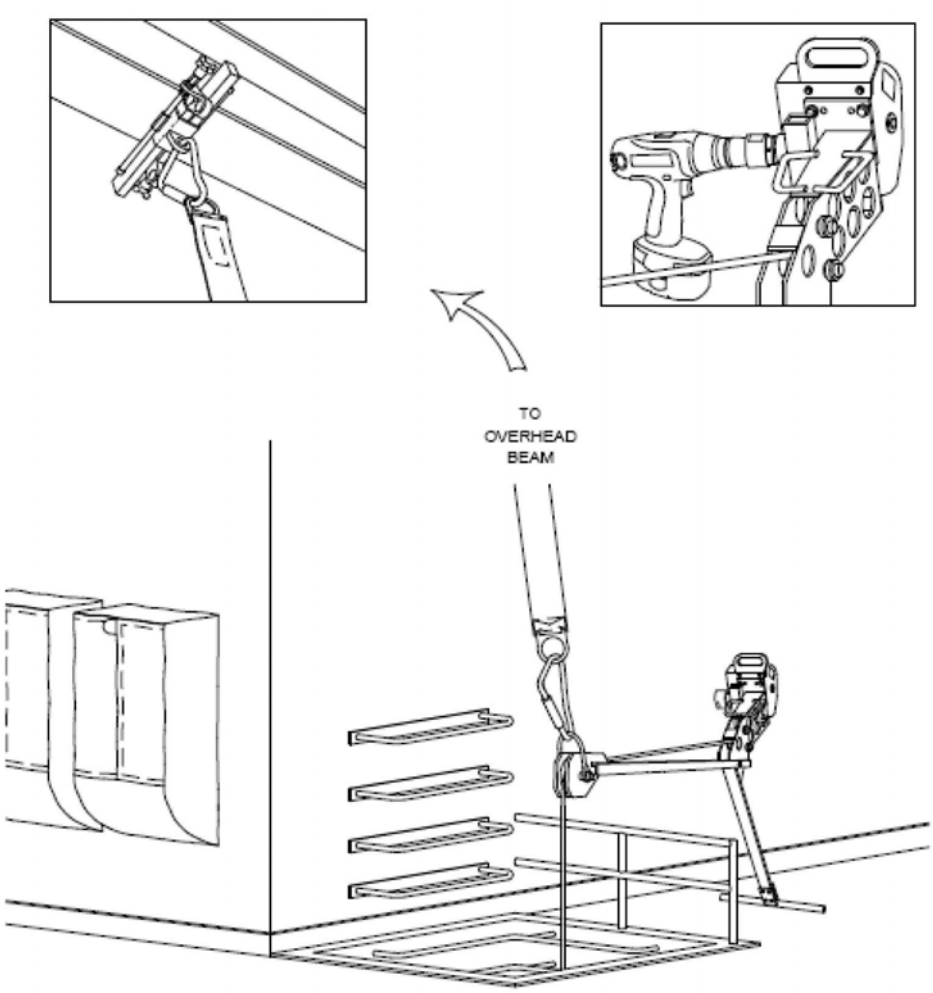
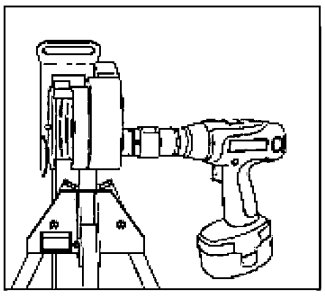


Figure 074-M-2. Pole Hoist

074-M.2.3 TRIPOD. The tripod is made of lightweight anodized aluminum and is designed for use inentry/retrieval operations over an edge or where no overhead anchorage point is present (see Figure 074-M-3).The tripod uses two persons standing on the rear leg extensions as counterweight. Like the pole hoist, the tripod is collapsible for portability and stowage and is assembled with attached zinc-plated steel quick-release pins.



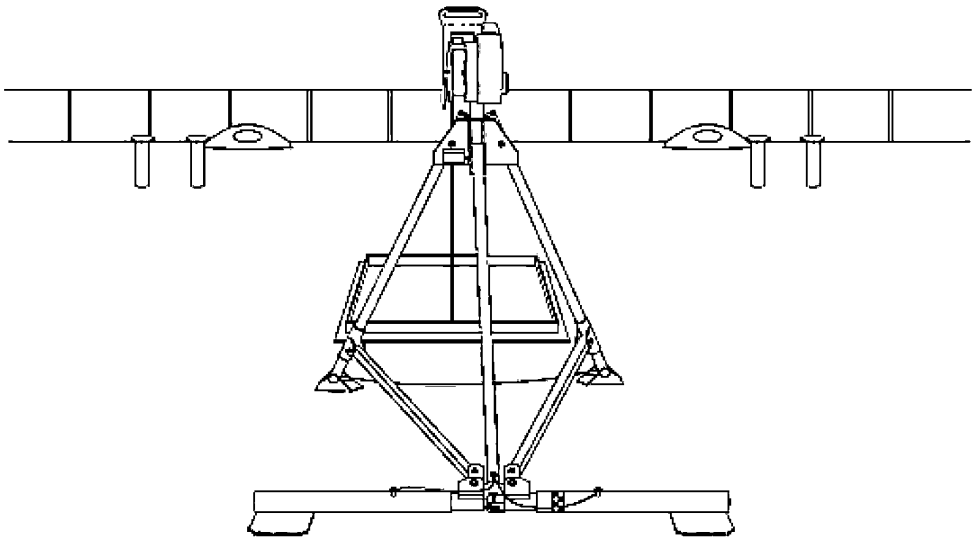


Figure 074-M-3. Tripod

074-M.2.4 POWER DRILL KIT. The Hilti®UH240-A Power Hammer Drill Kit contains a cordless hammer-drill with rubber-padded side grip for use by right or left-handed persons to provide a securehold. The kit also includes two B24/3.0 nickel-metal hydride batteries and a C7/36-ACS fan-cooled battery charger in a hard plastic toolbox. The drill has three speeds, operating up to 1,950 revolutions per minute and also has 15 torque adjustment settings. The forward/reverse switch is equipped with an interlock to prevent switching directions while the drill is running.

The charger has 200 watts of output power and can fully recharge a battery in about 30 minutes. The charger recharges batteries in refresh mode and ensures all cells are fully charged; conventional chargers will stop charging as soon as the first cells are fully charged.

074-M.3 OPERATION.

Follow all operating instructions located in the Rescue Davit System Technical Manual, S5090-BY-OMP-010.

APPENDIX N

INDEX

GLOSSARY

Air Contaminant - A substance or material that is foreign to the normal composition of the atmosphere, usually occurring in the form of aerosols, dusts, fumes, mists, gases and vapors.

Approved (For the Purpose) - Equipment or materials that have been tested, evaluated and determined to be acceptable by a recognized testing laboratory or inspection agency according to the requirements of a particular code or specification for a particular purpose, environment or application.

Area Coordinator - The official who initiates action to ensure that, within assigned areas, there is an effective, integrated and coordinated shore establishment. Overseas area coordinators are responsible to the appropriate fleet commanders-in-chief. Within the continental United States, area coordinators are assigned to Naval district commandants who report directly to the commanding officer.

Atmosphere - The immediate gaseous surrounding of a particular location or confined space, including normal air plus any air contaminants and oxygen deficiency/excess.

Atmospheric Contaminant - See Air Contaminant

Auto Ignition Plant - The minimum temperature required to initiate self-sustained combustion of a substance independent of external ignition sources of heat.

Autogenous Ignition Temperature - The temperature just adequate to cause the vapors from a petroleum product to burst into flames without the application of a spark or flame.

Blister - An enclosed bulging bubble-like projection (as in paint) which may be filled with a liquid (saltwater or solvent) or a gas (air). Blisters can occur in any painted tank (i.e., JP-5, gasoline) due to improper painting procedures such as poor ventilation during application and curing or incomplete surface preparation. Broken blisters must be repaired because of potential for occurrence of rusting.

Boundary (Spaces) - The outermost border or limit immediately surrounding a confined space, above, below and on all sides, such as the outside walls of a fuel tank.

Canister (Air Purifying)[<]!emph - A container with a filter, absorbent or catalyst, or any combination thereof, which removes specific contaminants from the air drawn through it.

Canister (Oxygen-Generating) - A container filled with a chemical which generates oxygen by chemical reaction.

Ceiling Concentration (C) - The upper concentration of contaminants that must not be exceeded, even instantaneously.

Ceiling Level - The maximum airborne concentration of a toxic agent to which personnel may be exposed for a specified period of time.

GLOSSARY - Continued

Centrifugal Dry Spark Arrester - A device used to remove particulate suspended in incinerator smoke. It works by drawing the smoke through a cyclone chamber where the heavier particulates are thrown to the sides of the chamber by centrifugal force and then are collected and removed.

Closed Compartment Opening Request - Form submitted to the GFE via the chain of command requesting gas free engineering services in support of opening a closed space. This request only allows opening. Entry is authorized using the gas free certificate. This form may also be used to request other gas free engineering services such as ventilation or planning for cold work.

Closed Compartment or Poorly Ventilated Space - Any spaces which are not well ventilated such as storerooms, reefers, double bottoms, structural blisters and voids. Can also be spaces which are normally occupied but which have been vacated, closed or sealed.

Cofferdam - A protective space or shell surrounding a gasoline storage tank and filled with an inert gas such as nitrogen or carbon dioxide.

Cold Work - Operations which involve only inspections, cleaning or minor repair where no hot work will be conducted. Examples are space inspections, spray painting, chemical cleaning and the use of any strippers, thinners, paints or cleaners that produce vapors.

Collection, Holding and Transfer System (CHT) - The system for handing sewage and waste water.

Combustible Dust - Particles capable of undergoing combustion or burning when subjected to a source of ignition.

Combustible Liquids - Any liquid having a flash point at or above 37.8°C (100°F).

Combustible (Explosive) Meter - An instrument used to test atmospheres for concentrations of flammable gases and vapors.

Concentration - The quantity of a substance per unit volume. Examples of concentration units are:
- mg/m^3 ; milligrams per cubic meter; for vapors, gases, fumes or dusts.
- ppm; parts per million; for vapors or gases.
- fibers/cc; fibers per cubic centimeter; asbestos.

Confined Space - A space which has restricted openings for entry and exit and in which hazardous contaminants could be expected to be produced but not removed by ventilation; or in which oxygen could be expected to be depleted or enriched. A confined space is any area that people aren't supposed to enter and occupy on a routine basis and that also has the potential for containing or accumulating a dangerous atmosphere. A confined space also may have these characteristics:
- It is large enough for a worker to enter and do work.
- It contains or can contain a hazardous atmosphere, produced by such things as chemicals, sludge or sewage.
- It is laid out so that anyone who enters could be trapped or asphyxiated (walls that converge or a floor that slopes down and tapers to a small cross-section, such as a fuel tank).
- Confined spaces may include, but are not limited to: double bottoms, voids, tanks, vats, degreasers, reaction vessels, boiler water and firesides, ventilation and exhaust ducts, pipelines and condensers.

Contaminant - A material or agent which is foreign to a specified or desired condition or circumstance.

Continuous Testing - Used to determine the presence of flammables, toxicants or oxygen, conducted throughout the course of an operation, with not more than 15 minutes between tests. See also Periodic Testing.

Corrosive Material - A solid, liquid or gas that degrades other substances (especially metals) through chemical action. It can burn, irritate or destructively attack organic tissue.

Deficiency of Oxygen - An atmosphere where the oxygen content has been reduced below the point at which a person may work comfortably (approximately 19.5% by volume).

Detector Tube - A glass tube which utilizes a sensitive chemical (in a suspension of silica gel) which produces color change whenever contaminated air is pulled through it.

GLOSSARY - Continued

Diffusion	-	A process to disperse and equalize a physical state (such as temperature) or a gas (when one gas is introduced to another).
Dilution Ventilation	-	Introduces air into a space to dilute the contaminated air within the space to an acceptable level. Generally used for the control of flammable, oxygen-deficient or -enriched areas rather than control of toxicants.
Dust	-	A solid, dry, mechanically-produced particle resulting from operations such as sanding and grinding.
Emulsion	-	A liquid suspended in another liquid, of two types: water in fuel and fuel in water. Water in fuel is the most common and appears as a light to heavy cloud. Fuel in water is reddish, grayish or blackish in color and very sticky or gummy, adhering to most materials it contacts.
Explosive-proof	-	Describes an apparatus, device or equipment that is tested and approved for use in hazardous atmospheres, as defined in the National Electrical Code. Explosive-proof devices are designed to withstand internal explosions and prevent hot vapors or particles from exiting before they become significantly cooled.
Explosive Range	-	A scale that indicates the explosive nature of gases or vapors. The relationship of the concentration of the vapor present, its temperature and pressure is expressed as a percent by volume in air. If the explosive range fails below the lower explosive limit (LEL), the mixture of air and vapor is too lean for an explosion. If the explosive range is above the maximum explosive range, or upper explosive limit (UEL), the mixture of vapor and air is too rich to be explosive.
Explosive or Flammable Limits	-	See Explosive Range.
Facepiece	-	That portion of a respirator which covers the wearer's nose and mouth in a quarter-mash (above the chin) or half-mask (under the chin) or that covers the nose, mouth and eyes in a S9086-CH-STM-030 74-N-7 full facepiece. It is designed to make a gas-tight or particle-tight fit with the face and includes the headbands, exhalation valve(s) and connections for an air-purifying device or respirable gas source, or both.
Fire Point	-	The temperature at which sufficient vapor is given off to continue burning after ignition.
Flammable Liquids	-	Any liquid having a flashpoint below 37.8°C (100°F), except any mixture having components with flashpoints of 37.8°C (100°F) or higher, the total of which make up 99% or more of the total volume of the mixture.
Flammable and Combustible Materials	-	All liquids, solids and gases having a flashpoint below 93.3°C (200°F). Also includes materials such as coolants, hydraulic fluids, lubricants and aerosols which require protection from ignition sources regardless of flashpoint.
Flash Point	-	The lowest temperature at which a liquid gives off sufficient vapor to form a flammable mixture with air (above the liquid surface).
Fume	-	Solid particles formed by condensation of metals from the gaseous state.
Gas Feeding	-	Operations performed in testing, evaluating, removing or controlling hazardous materials or conditions within or related to a confined space which may present hazards to personnel entering or working in, on or adjacent to the space.
Gas Free Engineer (GFE)	-	An individual qualified in accordance with NSTM Chapter 074, Volume 3, Section 18, certified by the Commanding Officer and responsible for the administrative and technical aspects of the activity gas free engineering program.
Gas Free Engineering Assistant (GFEA)	-	Same as GFE except that the CO's written authorization is required when performing duties in the absence of the GFE.
Gas Free Engineering Personnel (GFEP)	-	Personnel who work within the gas free organization. These personnel include the GFE, GFEA, GFEPO and FM.
Gas Free Engineering Petty Officer (GFEPO)	-	An individual qualified and certified in accordance with NSTM Chapter 074, Volume 3, Section 19.

GLOSSARY - Continued

Gases - A form of matter diffuses and occupies space. A gas is not solid or liquid at STP [0°C (32°F), 14.696 lb/in_2 absolute].

General Ventilation - Provides, in a confined space, uncontaminated air for breathing to maintain general comfort of personnel. It provides one complete air change every three minutes.

Hazardous Material (HM) - Any material that, because of its quantity, concentration or physical, chemical or infectious characteristics, may pose a substantial hazard to human health or the environment when released or spilled into the environment.

Hazardous Substance/ Atmosphere - A substance or atmosphere which by reason of being explosive, flammable, toxic, oxidizing, irritant, corrosive or otherwise harmful, is capable of causing serious injury, death or property damage.

Hazardous Waste (HW) - Any discarded material (liquid, solid or gas) that meets the definition of an HM or is designated as HW by the Environment Protection Agency or state or local authority.

HM/HW Coordinator - Person designated by the Commanding Officer to be responsible for proper shipboard management of HM/HW, according to OPNAVINST 5090.19 (series).

Hot Work - Any operation which involves flame, spark or temperatures in excess of 205°C (400°F) in the presence of flammables or flammable atmospheres. Can be caused by such things as riveting, grinding, abrasive blasting, drilling, welding and flame cutting, lighted cigarettes, static sparks, electric cooking apparatus, welding heaters and space heaters, non-explosion-proof lights, paint chipping, deck grinding, chiseling, hammering or electric motors.

Hydrocarbon - A compound containing only carbon and hydrogen. Hydrocarbons are the principal constituents of petroleum. At room temperature, the lightest hydrocarbons are gases (methane CH_4), but with increasing molecular weight, the compounds are in liquid form (octane, C^8 H_{18}) and, finally in solid form (eicosane, $C_{20}H_{42}$). There are more than 100 hydrocarbons in gasoline.

Hydrogen-Ion Concentration - Abbreviated pH, term used to express the apparent acidity or alkalinity of aqueous solutions. A pH of 7 indicates a neutral solution; values below 7 indicate acid solutions and values above 7 indicate alkaline solutions.

IDLH - See **Immediately Dangerous To Life Or Health**.

Ignition Temperature (Point) - See **Auto Ignition Point**.

Ignition - The act or action of causing a substance to burn; the means whereby a material starts burning.

Immediately Dangerous To Life Or Health (IDLH) - Any atmosphere that meets one or more of the following conditions: flammable vapors at a concentration of 10 percent or greater of the lower explosive limit (LEL); an oxygen content of less than 19.5% or greater than 22%; the presence of toxicants above a level that would allow personnel to escape within 30 minutes without impairment or irreversible health effects.

Imminent Danger - A condition which immediately poses a threat of serious injury, illness or the loss of life.

Incompatible HM/HW - Any hazardous materials that react with each other to produce undesirable products.

Inert Gas - A gas mixture that is non-flammable, will not support combustion and contains a maximum of three percent by volume of oxygen.

Inerting - A process in which an inert or nonflammable gas, such as carbon dioxide, helium, argon or nitrogen, is introduced into an atmosphere to such a degree that the oxygen/flammable vapor content of the atmosphere will not burn or explode.

Initial Certification - The certificate issued by gas free engineering personnel as a result of initial testing.

Initial Testing - Testing combined on a confined space when the space is first opened after a period of closure or servicing.

Intrinsically Safe - An item or piece of equipment which by design does not have, or is not capable of producing, sufficient levels of energy to cause ignition. An intrinsically safe device can be operated in a hazardous atmosphere without igniting that atmosphere.

GLOSSARY - Continued

Irritant	-	Substance which in contact with living tissue can cause burning or itching.
Isolation	-	A process whereby a confined space is removed from service and completely protected against the inadvertent release of hazardous material into the space. Isolation can be accomplished by blanking off; blocking/disconnecting all mechanical linkage, electrical isolation or other specified means.
JP-5	-	A high-flashpoint, kerosene type aircraft turbine fuel specifically designed for storage and use on Naval ships.
Local Exhaust Ventilation	-	Captures contaminants as they are generated, draws them into the system duct work and removed them.
Lower Explosive Limit (LEL)	-	The minimum percent by volume of a gas that, when mixed with air at normal temperature and pressure, will form a flammable mixture.
Lower Explosive Range	-	See **Lower Explosive Limit**.
Lower Flammable Limit (LFL)	-	The minimum concentration of a combustible gas or vapor in air, usually expressed in percent by volume at sea level, which will ignite if a sufficient ignition source of energy is present.
Material Safety Data Sheet (MSDS)	-	A written or printed document about a hazardous material which is prepared and submitted by a manufacturer, product supplier or distributor. Each MSDS contains the data elements required in 29 CFR 1910.1200, as outlined in Appendix D.
Mechanical Ventilation	-	Provides fresh air when needed, independent of the direction of the wind or temperature.
MOGAS	-	Combat automotive gasoline which has a low octane rating that may cause knocking in engines. The relative amount of lead influences the octane rating.
Multigas Detector (DRAGER)	-	A single multi-purpose gas detector pump with calorimetric tubes used to detect over 100 toxic gases/vapors.
Navy Occupational Safety and Health (NAVOSH) Standards	-	Occupational safety and health standards published by the Navy which include, are in addition to, or are alternatives for, the OSHA standards which prescribe conditions and methods necessary to provide a safe and healthful working environment.
Negative Pressure	-	A pressure less than atmospheric pressure. Gases and liquids flow from higher pressure to lower pressure areas; air is drawn into an area of negative pressure.
NIOSH/MSHA	-	National Institute of Occupational Safety and Health/Mine Safety Health Administration.
Non-Sparking	-	Materials that do not produce a risk.
Odor Threshold Limit	-	The lowest concentration of a contaminant in air that can be detected by the olfactory sense.
OSHA Standards	-	Those standards issued by the Department of Labor's Occupational Safety and Health Administrator pursuant to Section 6 of the OSHAct.
Outgas	-	To remove imbedded gas from a substance by heating.
Oxidizing Material	-	A chemical compound that spontaneously releases oxygen at normal temperature and air pressure or under slight heating. Oxidizers can react vigorously with may types of materials, especially organic substances such as petroleum products.
Oxygen-Deficient Atmosphere	-	Any oxygen concentration less than 19.5 percent at normal atmospheric pressure.
Oxygen-Enriched Atmosphere	-	Any oxygen concentration greater than 22 percent by volume at normal atmospheric pressure.
Oxygen Indicator	-	Measures atmospheric concentrations of oxygen over a range of 0–25 percent. Typical application is to check for potential oxygen-deficient atmospheres during post fire operations.
Particulate Matter	-	Solid contamination appearing as dust, powder, grains, flakes, fiber or stains, usually removable by settling, filtration or centrifugal purification.
PEL	-	See **Permissible Exposure Limit**.
Percent of Explosibility	-	An arbitrary term based on the assumption that the concentration of gas at the lower limit of flammability is 100 percent explosive.

GLOSSARY - Continued

Periodic Testing - Testing conducted during the course of an operation at intervals greater than 15 minutes, based on the nature of the space, its contents and the nature of the operation. See also **Continuous Testing**.

Permissible Exposure Limit (PEL) - The maximum permissible concentration of a toxic chemical or exposure level of a harmful physical agent to which personnel may be exposed. PEL is based on a time-weighted average (TWA) for a normal 8–hour day, 40–hour, 7–day week.

Pressing-Up - The process of completely filling a space with liquid to displace flammable vapor/air mixtures.

Purging - The method by which gases, vapors or other airborne impurities are displaced from a confined space.

Qualified Person - A person designated, in writing, as capable (by education or specialized training) of anticipating, recognizing and evaluating personnel exposure to hazardous substances or other unsafe conditions in a confined space. This person shall be capable of specifying necessary control or protective action to ensure personnel safety.

Reactive Material - A solid, liquid or gas that is chemically unstable at normal temperature and air pressure; capable of undergoing violent change when subjected to heat, shock, mixture with water or other chemicals.

Retesting and Recertifying - The process of testing, evaluating and certifying a confined space by the gas free engineer using the same procedures required for initial testing and certification when the certificate expires without entry, work or testing and updating of the certificate; or when conditions occur which alter the initial conditions found or specified.

Self-Contained Breathing Apparatus (SCBA) - Type of respirator which allows the user complete independence from a fixed source of air. Various kinds of SCBAs are: Open circuit, where user air is expelled and replenished by air from a compressed air cylinder, closed circuit or rebreathing respirator, which allows the user to rebreathe exhaled air.

Shelf Life - A period of time for which an instrument can be used without degradation, usually specified by the manufacturer.

Short Circuiting - The procedure of exhausting the supply air before it circulates through a space.

Short Term Exposure Limit (STEL) - The maximum concentration of a substance to which personnel can be exposed for up to 15 minutes, without significant physiological effects (i.e., irritation, narcosis, impairment of self-rescue), provided that no more than four exposures per day are permitted and at least 60 minutes elapses between exposure periods.

Short Term Lethal Concentration (STLC) - A concentration of a substance which is lethal within 10 minutes of exposure.

Smoke - Airborne contaminant which includes the products of combustion, pyrolysis or chemical reaction of substances in the form of visible and invisible solid and liquid particles and gaseous products in air.

Standard - A rule, established to competent authority, which designates safe and healthful conditions or practices under which work must be performed to prevent injury, occupational illness or property damage. Standards are:

• **Criteria** those parts of a standard which establish a measurable quality, i.e., specifications, inspection intervals.

• **Equivalent Criteria** - the measurement of equivalency, which is a judgement based on the preponderance of information available.

Standby Person - The person trained in emergency rescue procedures, assigned to remain on the outside of the confined space and to be in communication with those working inside.

STEL - See **Short Term Exposure Limit**.

Steam Blanketing - A method for making the outer boundaries of a space Safe for Hot Work by using steam to displace and carry off flammable vapor/air mixtures within a space.

STLC - See **Short Term Lethal Concentration**.

GLOSSARY - Continued

Storage	-	The holding of HM or HW for a temporary period, after which time the HM is used or stored elsewhere, or the HW is treated, disposed of or stored elsewhere.
Supplied Air Respirators	-	Also called air-line respirators, classified as follows: • **Demand** - a respirator which supplies air to the user on demand (inhalation) which creates a negative pressure within the facepiece. • **Pressure-Demand** - a respirator which maintains a continuous positive pressure within the facepiece. • Continuous Flow - a respirator which maintains a continuous flow of air through the facepiece.
Supply Ventilation	-	Moving fresh air into a compartment or space and displacing contaminated air through any available openings.
Threshold Limit Values (VLV)	-	Levels of airborne concentrations of physical agents, expressed in parts per million (ppm), that represent conditions under which average personnel may be repeatedly exposed, during normal working hours, without adverse effects. There are three subdivisions. • **Time-Weighted Average (TWA)** - the most commonly used of the TLV subdivisions, calculated in 8–hour days, 40–hour, 7–day weeks. • **Short Term Exposure Limit (STEL)** - 4 excursions, less than 15 minutes each, 60 minutes apart. • **Ceiling Limit** - concentration of a substance above which personnel should not be exposed, even instantaneously.
Time-Weighted Average (TWA)	-	See **Threshold Limit Values**.
TLV	-	See **Threshold Limit Values**.
Toxic Material	-	A solid, liquid or gas that can damage living material, impair the central nervous system or cause illness or death through inhalation, ingestion or skin absorption.
Toxic or Hazardous Atmosphere	-	An atmosphere containing a concentration of air contaminants sufficient to cause injury to personnel.
Toxicity Limits	-	The limits of a vapor from a certain minimum concentration (lower limit) to a maximum concentration (upper limit). Above a certain maximum concentration of a vapor in a space, life cannot exist.
Toxicity	-	Of poisonous quality, especially in relation to concentration of gas/vapor.
TWA	-	See **Time-Weighted Average**.
Upper Explosive Limit (UEL)	-	Upper end of the explosive range. Concentrations above this limit are too rich to explode or burn. Concentrations below the UEL are within the explosive range.
Vapors	-	Gaseous form of a substance that is normally liquid or solid.
Ventilating	-	Term given to the process of moving air into or from a compartment or space.
Ventilation	-	The ability to move air.
Volatility	-	The readiness of a liquid to vaporize or evaporate. The tendency to be readily diffused or dissipated in the atmosphere, especially at ordinary temperatures.

Ref: NAVSEAINST 4160.3A NAVSEA S0005-AA-GYD-030/TMMP

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